



International trends in public perceptions of climate change over the past quarter century

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Public perceptions of climate change are known to differ between nations and to have fluctuated over time. Numerous plausible characterizations of these variations, and explanations for them, are to be found in the literature. However, a clear picture has not yet emerged as to the principal trends and patterns that have occurred over the past quarter-century or the factors behind these changes. This systematic review considers previous empirical research that has addressed the temporal aspects to public perceptions. We address findings that have been obtained since the 1980s and using a range of methodologies. In this review, we consider early, seminal work examining public perceptions; survey studies carried out over long timescales and at an international scale; detailed statistical analyses of the drivers of changing perceptions; and qualitative research featuring a longitudinal component. Studies point to growing skepticism in the latter 2000s in some developed countries, underpinned by economic and sociopolitical factors. Even so, in many parts of the world, there has been growing concern about climate change in recent years. We conclude that the imbalance in the literature toward polling data, and toward studies of public perceptions in Western nations (particularly the United States), leaves much unknown about the progression of public understanding of climate change worldwide. More research is required that uses inferential statistical procedures to understand the reasons behind trends in public perceptions. The application of qualitative longitudinal methodologies also offers the potential for better appreciation of the cultural contexts in which climate change perceptions are evolving. © 2014 The Authors. *WIREs Climate Change* published by John Wiley & Sons, Ltd.

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INTRODUCTION

The ways in which individuals, societies, and polities respond to climate change are in many cases contingent on public perceptions of its causes, consequences, and wider implications.^{1–3} As such, understanding popular opinion on climate change is critically important. Particularly (but not only) in states with electoral systems, policy legitimacy matters at all stages of the policy process, for both private

and public entities.⁴ In the context of climate change, the major emissions reductions required, the development and deployment of low-carbon energy technologies, and the implementation of adaptation measures all require some degree of citizen involvement, from the granting of policy mandates to active behavioral change.^{5,6}

Alongside influences such as lobbying by incumbent interests, and institutional and structural factors, all of which may compel or constrain political responses to climate change,⁷ public opinion has compounded the widespread political reluctance in many countries to enact legislation that could be received unfavorably by electorates and by the powerful economic interests that both support and depend on those electorates.^{8–11} At the individual level, behaviors of significance for climate change may be influenced by a person's attitudes toward climate change, but they are also subject to these wider sociocultural and political factors^{12–14}, which, while from a psychological perspective are considered external and contextual, from a sociological perspective are internal to the understanding of climate change dilemmas. The ways in which these individual and structural factors inter-relate are complex^{14,15} but the types of attitudes which have been shown to be important as influences on public and private sphere action include individuals' recognition of the reality of climate change, acceptance of a human component in the causation of climate change, degree of concern about its impacts, and beliefs about personal and wider responsibilities for addressing it.^{15–17}

For some time now, a majority of people worldwide have been of the view that climate change is a serious problem, and that people are already being harmed by it.¹⁸ Such wide-ranging public concern and awareness have developed since the emergence of climate change as a major environmental concern during the 1980s.^{19,20} This said, there has been widespread unease expressed in more recent years that sections of the public appear to have lost faith in climate science and scientists, and that the public and experts may be increasingly diverging in their assessments about climate change.^{21,22} In some parts of the world, there has been a growth in public skepticism about climate change (however defined^{23–29}) since the late 2000s. This has been attributed to a range of factors, including climate fatigue, misleading media representations, the global financial crisis of 2008, and social attenuation of risk.³⁰

Temporal changes in public perceptions of climate change warrant careful attention, as trends in opinion can be consequential for national and international responses to climate change and may

be underpinned by a range of different social forces and physical phenomena. With over two decades of research on public perceptions of climate change, we are now in a position to take stock of the key trends over this time period. There has, to date, been no attempt to review the full range of literature relating to trends in public perceptions of climate change (though there have been earlier overviews of polling data in the United States,^{20,31} as well as some commentary on international polling over time^{32,33}).

Here, we present findings from a systematic literature review of studies on public perceptions of climate change, that have used longitudinal methods to examine patterns of change and to identify the drivers of trends in public opinion. We also include early, seminal research in order to contextualize public perceptions and research approaches at the time climate change was beginning to be recognized in the public domain.

While acknowledging that public opinion formation, patterns, and trends can be analyzed and understood through different paradigms (e.g., political science)^{34,35} our primary focus here is on attitudinal trends as revealed through direct measures of public perceptions. Data sources of relevance here are primarily public polls and surveys (but also some interview, focus group and ethnographic data), rather than proxy indicators of opinion such as newspaper coverage, internet searches, or membership of campaign groups, which are often used as measures of 'issue salience' or 'concern' among citizens.¹¹ Surveys provide more direct, 'demand-driven' indicators of public concern than newspaper indices, which are at least partly driven by newspaper agendas and in turn likely to influence or reinforce public opinion (i.e., 'supply driven'); while internet search data (e.g., Google Trends) and campaign/political group membership capture more active (collective) public responses to social issues.¹¹ Yet, while methods such as surveys can provide a useful gauge of opinion—and also offer insights into knowledge, beliefs, and individual responses—they are often underpinned by individualistic assumptions that may construct 'the public' in certain (limited) ways,³⁶ as well as being subject to methodological limitations (e.g., question framing), some of which we discuss later in this review.

The objectives of this review are fourfold. First, to outline international trends and patterns in public perceptions of climate change over the past quarter-century; second, to summarize the available longitudinal evidence on what might account for these; third, to highlight the types of approaches being used to examine the temporal component of public perceptions of climate change; and, fourth, to

draw conclusions about the strengths and weaknesses of the available research and to point to areas as yet under-developed.

Early studies in particular, and some continuing work in the United States and elsewhere, have used the terms ‘global warming’ and ‘greenhouse effect’ synonymously with ‘climate change’. For consistency, throughout this review we use only the latter term, while acknowledging that variations in terminology can lead to different types of responses from public participants,^{37–39} a point to which we return later.

SYSTEMATIC LITERATURE REVIEW

For this study, we carried out a literature search, using the principles of a systematic literature review, to identify relevant articles addressing changes in public perceptions of climate change over time. The *Web of Science* database was searched for publications published between 1980 and 2014, using a Boolean search term designed to retrieve a comprehensive body of work addressing public perceptions of climate change.^a This search identified 2610 citations, from which a prospective list of 240 studies was derived, based on a preliminary inspection of article titles and abstracts. The 240 articles were fully screened by three of the authors of this study, following which 35 articles were retained for the purpose of the present review. The criteria for inclusion were as follows: (1) the study presents original empirical data, detailed original analysis and/or commentary on pre-existing empirical data (e.g., opinion polls) concerning climate change perceptions; (2) the study utilizes data at more than one time-point, in such a way as to inform understanding of changes in public perceptions over time; and (3) the study addresses change over time in such a way as to be generalizable to a wider population or population group (as opposed to, e.g., laboratory experiments with no clearly defined target population). In order to put recent trends into historical perspective, we additionally incorporate seminal cross-sectional research studies of public perceptions from the late 1980s and early 1990s. These were obtained through extraction as part of the systematic review described above, plus three further early studies of which the authors of the present review were previously aware. Furthermore, because many large-scale international and longitudinal survey studies (e.g., conducted by polling and think-tank organizations such as Gallup and Pew Research Centre) have not been published in the academic literature, we incorporate 18 studies from the gray literature and web-based publications, also using the inclusion criteria above. The selection of this material has necessitated some discretion on

the authors’ part, given the large number of reports available which have commented on changing public opinion. One further qualitative longitudinal study of which the authors were previously aware and which matched inclusion criteria was also included.

The final literature review included 39 peer-reviewed publications and 18 studies from the gray literature and/or web-based reports. The review approach utilized for the present study is outlined in Figure 1.

Overview of the Identified Publications

The studies obtained from the literature review fall into four main types, which we use to structure our discussion of changing public perceptions.

First, we consider findings from some of the earliest and relatively small-scale studies carried out in the 1980s and early 1990s. This research is useful for understanding the nature of public awareness of climate change at this early point in time, such as a commonplace conflation between climate change and stratospheric ozone depletion. To a large extent, these early studies appraised the accuracy of people’s knowledge in comparison to expert understanding, and were conducted only in developed nations.

Second, we provide an overview of findings from representative survey and polling data carried out since the early 1980s across the globe. As this second type of study incorporates a large amount of material across an extended time span, we divide this section into four time periods, reflecting broad shifts in public perceptions. These studies enable insights to be obtained into public perception trends at the macro level; however, for the most part do not provide direct, empirical evidence of the drivers of such trends.

Third, we outline findings from studies utilizing time series and other inferential statistical approaches to draw conclusions about the drivers of changing public perceptions, such as socioeconomic and meteorological factors. These studies provide some of the most robust insights into the reasons behind changing public perceptions. They are, however, limited to examinations using a limited number of variables, and have been conducted only in developed nations.

Fourth, we outline insights obtained from a small number of qualitative (e.g., anthropological) studies that have directly considered a temporal component to public perceptions. Whilst qualitative work is able to offer in-depth insights into people’s understanding of climate change, there has to date been little focused analysis undertaken of how such understanding has itself changed over time.

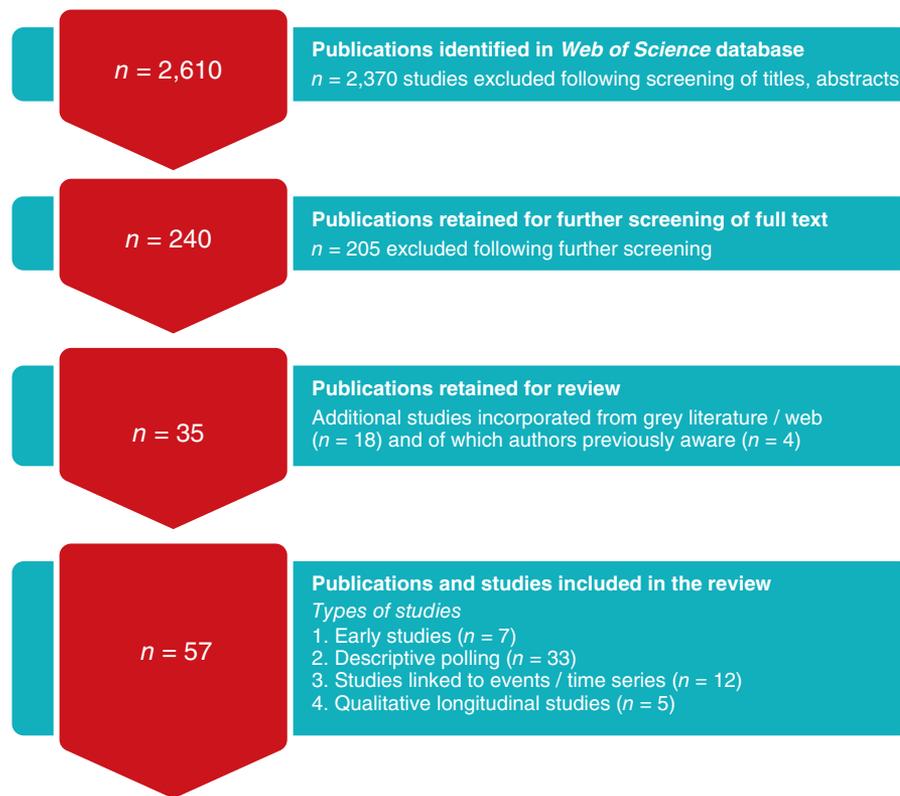


FIGURE 1 | Systematic review process.

The body of work obtained from the literature review is summarized by study type and key features in Table 1.

TRENDS IN PUBLIC PERCEPTIONS—INSIGHTS FROM THE LITERATURE

We now examine in detail the identified literature, in order to provide an overview of changes in public perceptions of climate change since the 1980s.

Early Cross-Sectional Research—Public Perceptions in the Late 1980s and Early 1990s (Study Type 1)

We begin by considering seven small-scale, cross-sectional studies carried out in the late 1980s and early 1990s in the United States, New Zealand, and Sweden. For ease of comparison, we also discuss here a later replication of one of these early studies undertaken in 2009. The studies considered here were some of the first to examine perceptions of climate change, at a point in time when it remained a relatively novel concept in public discourse.

One of the earliest such studies entailed ethnographic interviews with householders, carried out across four U.S. states between 1989 and 1992.^{40,41} This work concluded that climate change was starting to feature in people's understanding through being integrated into their existing conceptualizations of environmental risks. For example, climate change was often categorized as a subset of stratospheric ozone depletion, such that the burning of fossil fuels was perceived to contribute to the 'hole' in the ozone layer. Climate change was also often conflated in people's understanding with localized air pollution. Interestingly, this early research found that participants were of the view that the weather had *already* changed, an observation which has frequently been repeated in subsequent studies of public perceptions.⁴²

Early research carried out in New Zealand in 1989⁴³ concluded that, at this time, awareness of the subject of climate change was already universal (96% of a national survey sample having heard of it) although knowledge about the 'basic facts' of climate change was limited, with almost half the respondents knowing nothing about its causes, and only a quarter aware of the relevance of fossil fuel use. As with early U.S. studies, a confusion between ozone depletion

TABLE 1 | Overview of Studies Retained from the Systematic Review

Study Citations	Study Type	No. Studies	Overview of Study Type	Methodology and Data	Country/Location (No. Studies)	Strengths	Limitations
Refs 40, 41, 43, 45–48	1	7 (peer-reviewed)	Early cross-sectional research	Primarily small-scale, qualitative and survey-based	US (5), Sweden (1), New Zealand (1)	Permits insights at an early time-point	Limited to developed nations and 'deficit' interpretation
Refs 20, 25, 26, 31–33, 57–59, 64–81, 88, 90–94	2	15 (peer-reviewed) 18 (gray literature/web-based reports)	Opinion polls and large-scale survey data; peer-reviewed studies providing overviews of datasets, plus survey data reports from polling organizations and think-tanks	Public opinion polling, data collection online, postal, face-to-face	US (13), International (10), Europe (4), UK (4), Germany (1), Australia (1)	Large representative datasets often at international scale; some polling uses repeated measures over long time periods	Polling limited to small number of survey items testing basic attitudes; strong bias toward US data; majority of studies contain only descriptive statistics; cross-national comparisons affected by differing notions of what constitutes 'climate change'
Refs 96, 97, 101, 104, 105, 112–115, 122–124	3	12 (peer-reviewed)	Time-series analyses and repeated measures before/after significant events	Secondary analysis testing causal relationships between climate change perceptions and socioeconomic/meteorological factors	US (8); US & Europe (1), Europe (1), Japan & UK (1), Australia (1)	Inferential statistics used to analyze factors behind changing public perceptions	Limited to developed nations; reliant upon secondary polling data
Refs 135–139	4	4 (peer-reviewed) 1 (doctoral thesis)	Qualitative studies entailing longitudinal analysis and/or commentary on changing perceptions	Anthropological/ethnographic/discourse analytic	Russia/Siberia (3), UK (1), Peru (1)	Permits in-depth insights over time, and apprehension of culturally specific notions of climate change	Little deliberate use of qualitative longitudinal methodology

and climate change was identified—study participants, e.g., suggested that ozone depletion was a cause of climate change, or related higher temperatures associated with climate change to increased ultraviolet radiation.

This early work for the most part applied a ‘deficit’ model⁴⁴ in appraising public understanding, concluding, e.g., that people’s views were ‘seriously at variance with the scientific models of global warming’.⁴¹ Likewise, mental models and survey-based research carried out in 1992 in the United States^{45,46} reported that public understanding ‘suffer[s] from several basic misconceptions’.⁴⁵ This research again made the observation that most participants confused climate change with stratospheric ozone depletion, and were unaware of the causal role of anthropogenic carbon dioxide. Participants at this time-point were, however, argued to have a reasonable understanding of the consequences of climate change (e.g., temperature increases and changes to precipitation).

The mental models research described above is of particular interest when tracking changes in public perceptions over time, as this has been one of the only pieces of early academic research to have been replicated at a later date. Some 17 years after their original research⁴⁶ was carried out, in 2009, levels of awareness and comprehension of climate change were found to be far higher, at least among educated individuals.⁴⁷ Respondents in the more recent survey were also more likely to mention fossil fuel use and energy use in general, as a cause of climate change; conversely, the erroneous association with ozone depletion was much diminished. Strikingly, however, this research also found that people’s conviction that anthropogenic climate change is occurring was no higher in 2009 than it had been in 1992, that nonanthropogenic causes were even more frequently cited than previously, and that conflation of the concepts of ‘weather’ and ‘climate’ were as pronounced as they had been at the time of the earlier research.

Another early research project, using mixed methods and carried out in 1990 in Sweden,⁴⁸ observed that whilst a majority (92%) of participants had heard of climate change, most were unaware of its causes and consequences. A conflation with ozone depletion was again observed, and linkages between energy use and climate change were poorly perceived. For example, around a third of respondents’ preferred method for addressing climate change was through reducing chlorofluorocarbon (CFC)-using aerosols, with only 6% opting for energy saving.

These early studies, and the public misconceptions reported therein, related largely to the physical

and scientific aspects of climate change. A more complete exploration of perceptions surrounding the personal and societal implications of climate change would only become a focus in later work.

We next consider research which has examined public perceptions of climate change over time using nationally representative polling data taken at multiple time-points.

Survey Data—Changes in Indicators over Time (Study Type 2)

Multiple polls and research projects examining public perceptions of climate change are now regularly undertaken across the world. Here, we consider findings from 33 studies, which we divide into four indicative time periods broadly reflecting both the types of survey findings obtained and the shifts in emphasis of researchers over these time periods: (1) 1980s and early 1990s, showing increases in knowledge and awareness; (2) mid-1990s to the mid-2000s, a period marked by growing public concern but also variability in opinion; (3) mid- to late-2000s, showing declining public concern and increasing skepticism in some nations, with polarization of viewpoints within and between nations; and (4) 2010s, which so far suggest possible stabilization of public concern about climate change. Reflecting the greater availability of U.S. data, this is discussed in more detail; however, as far as possible we have endeavored to give equal attention to other regions.

Surveys and opinion polls since the 1980s have assessed public perceptions in a variety of domains through the use of precisely worded questions. A focus of many surveys has been to measure public attitudes toward the physical and scientific aspects of climate change (e.g., beliefs about an anthropogenic component); other questions have examined the extent to which people see climate change as a ‘problem’ or threat; as well as gauging levels of public concern and support for action at the national and individual level. Although a formal thematic analysis of the types of questions asked across these studies is beyond the scope of the present review, some of the main constructs of interest are presented in Table 2, together with example survey items and response categories, and illustrative citations.

Whilst we review survey studies from across the globe, it is important to note that meanings of ‘climate’ and ‘climate change’ vary within and between cultures, and that for nonscientists, local cosmologies,^{49–51} and emotional and sensory perceptions^{52,53} are critical to the way climate change is interpreted. Rudiak-Gould,⁵⁰ e.g., points out that

TABLE 2 | Survey Measures of Public Perceptions

Question Focus	Illustrative Survey Item	Response Options	Example Studies in Which Item Reported
Awareness and understanding of climate change	Have you heard or read anything about the issue of global warming?	Yes/no/not sure	Refs 20, 32
	Thinking about the issue of global warming, how well do you feel you understand this?	Very well/fairly well/not very well/not at all	Ref 20
Existence of climate change at present time	As far as you know, do you personally think that the world's climate is changing, or not?	Yes/no/don't know	Refs 73, 74, 105
	Do you think that global warming is happening?	Yes/no/don't know	Ref 70
Causes of climate change	Please list all of the things that you think could cause global warming	Open-ended response	Refs 46, 47
	Assuming global warming is happening, do you think it is ... ?	Caused mostly by human activities/caused mostly by natural changes in the environment (also 'none of the above' and 'other')	Ref 70
Perceived threat from climate change	How much you think [the greenhouse effect] threatens your personal health and safety?	7-point scale from 'minimal threat' to 'clear threat'	Ref 58
	Please tell me how serious a problem you personally believe global warming to be in the world?	Very serious/somewhat serious/not very serious/not serious at all/don't know	Refs 33, 57
	How serious a problem do you think climate change is at this moment?	10-point scale from 'not at all a serious problem' to 'extremely serious'	Refs 71, 88
	How serious a threat is global warming to you and your family?	Very serious/somewhat serious/not very serious/not serious at all/don't know	Ref 80
Seriousness of climate change compared to other issues	Which of the following do you consider to be the single most serious problem facing the world as a whole?	Eight possible 'problems' presented, including climate change, 'the economic situation', and 'armed conflicts'	Refs 71, 88
	What do you think will be the most important problem facing the world in the future?	Open-ended response (climate change coded together with other 'problems')	Ref 154
Certainty of climate science (with respect to existence, causation)	Most scientists agree that humans are causing climate change	5-point scale from 'strongly agree' to 'strongly disagree'	Refs 23, 74
	To the best of your knowledge, what percentage of climate scientists think that human-caused global warming is happening?	0% to 100%	Ref 70
	Is there solid evidence that the average temperature on earth has been getting warmer over the past few decades, or not?	Yes, mostly because of human activity/yes, mostly because of natural patterns/don't know	Refs 78, 79, 92, 112, 115, 122

TABLE 2 | Continued

Question Focus	Illustrative Survey Item	Response Options	Example Studies in Which Item Reported
Personal concern or worry about climate change	[Do] you personally worry about global warming a great deal, a fair amount, only a little, or not at all?	A great deal/a fair amount/only a little/not at all	Refs 20, 31, 64, 124
	Are you very worried, somewhat worried, not very worried or not at all worried about global warming?	Very worried/somewhat worried/not very worried/not at all worried	Ref 59
	How concerned, if at all, are you about climate change, sometimes referred to as global warming?	Very concerned/fairly concerned/not very concerned/not at all concerned/don't know/no opinion	Refs 73, 74, 91
Requirement for action on climate change (at national and personal level)	Do you think the United States should—or should not—agree to abide by the provisions of the Kyoto agreement on global warming?	USA should abide/USA should not abide	Ref 31
	[Regarding] whether it is necessary to take steps to reduce the impact of human activities thought to cause global warming or climate change. Would you say that you believe that ... ?	It is not necessary to take any steps/it is necessary to take modest steps over the coming years/it is necessary to take major steps starting very soon/don't know	Refs 32, 65
	I am prepared to greatly reduce my energy use to help tackle climate change	5-point scale from 'strongly agree' to 'strongly disagree'	Refs 74, 116
Open-ended/spontaneous response permitted	When you think of 'global warming,' what is the first word or phrase that comes to your mind?	Open-ended response	Ref 26
	Would you like to make any further comments about climate change?	Open-ended response	Ref 72

Items are abridged in some cases; some studies cited conduct secondary analysis of polls or overview previous findings.

the concepts most commonly used to correspond to climate and climate change in the Marshall Islands can refer to a broad range of environmental and cultural phenomena, including social transitions and even beliefs about changes to the passage of time itself. This author suggests that similar processes are likely to be relevant in other parts of the world, particularly given that for many societies ideas of culture and nature are not conceptually distinct. Although some separate research has argued that shared ideas about climate change do indeed exist across diverse cultures internationally,⁵⁴ the potential for cross-cultural variability in notions of climate change should nevertheless be borne in mind as a limitation in the case of the international comparisons of climate change perceptions reported in this section of the study.

With respect to intranational variability in climate change perceptions over time, a separate issue arises as to the potential for movement on key

indicators (e.g., people's level of concern or acceptance of the reality of climate change) to be overinterpreted as demonstrating a significant shift in public mood, rather than as reflecting the typical variability that is to be expected between polls and over time.^{55,56} With respect to public perceptions of climate change, there has at times been a tendency in media reports—as well as the research literature—to assert such shifts without reference to criteria (particularly any statistical basis) required to confidently draw those conclusions.

Although it is unclear at the present time what might constitute 'normal' variation in public perceptions of climate change over time, in an effort to preclude the drawing of undue inferences from polling data in the present review, we interpret changes over time taking into account the margins of errors of the surveys used. The margin of error provides an indication of how reliable results are, and is dependent on population and sample size. Most of the studies and public opinion polls reviewed in this section of the

study have a sample size of around 1000 (which yields an approximate margin of error of $\pm 3\%$ at the 95% confidence level). We therefore only report differences between two time-points where confidence intervals do not overlap (for most surveys, corresponding to a difference between two time-points of 6% or more) except in cases where findings are supported by statistical tests by the original authors, or are based on the interpretation of multiple polls by the authors of the studies reviewed.

1980s to Early 1990s: Increasing Knowledge and Awareness

Being the point in time at which data on public opinion toward climate change was just starting to be gauged, data from the 1980s are inevitably sparse compared to recent years. However, such evidence as there is suggests that during this decade public awareness, knowledge, and concern rose steadily, soon reaching levels comparable to those obtained in recent years.

Based on a review of several hundred polling studies carried out in the United States, including at this early time period, Nisbet and Myers²⁰ concluded that public awareness about climate change underwent a rapid increase through the second half of the 1980s. These authors presented findings from separately conducted national polls that showed that whereas in 1986 less than a half of respondents (between 39 and 45%) reported having heard or read anything about climate change, this proportion rose to around three-quarters (74%) of respondents by 1990. These authors noted, however, that levels of overall understanding were limited.

As in the earlier small-scale studies described above, larger-scale survey studies also point to a conflation with localized air pollution, CFCs and ozone depletion in respondents' attribution of causes of climate change³³. Nevertheless, even at this early point in time, respondents from many parts of the world were already of the view that climate change had begun to happen.^{57, b}

Despite limited levels of understanding during this early period, polls nevertheless show public concern rose rapidly. In one of the first polls of its kind to be conducted, only 43% of U.S. respondents in 1982 saw climate change as either a 'very' or 'somewhat' serious problem. Over three subsequent survey waves, this figure reached 75% by 1989,⁵⁸ as illustrated in Figure 2. This finding is paralleled in other indicators taken during the late 1980s measuring the perceived level of threat from climate change. For example, whereas only 37% of respondents in 1984 perceived that climate change constituted a future problem for

one's children or grandchildren, this had risen to 65% by 1988.⁵⁸

Findings from national surveys across 24 countries in 1992^{33, 57} also showed that pluralities in each of these countries already viewed climate change as a subject of concern, with just over half of all respondents at an international level rating it as a 'very serious' problem. There was substantial variability between nations at this time, however—ranging from 26% of Nigerians and 34% of Finns considering climate change to be 'very serious', to 72% of Portuguese and 73% of Germans.

Some limited polling data also offer insights into changing perceptions in Europe around this time. Survey research from 1988, based on over 10,000 respondents from across Europe, found that more than three-quarters of respondents were already worried about climate change (43% reported being 'very worried' at this time, a further 33% 'somewhat worried'). In a subsequent survey wave in 1992, the proportion of Europeans assigning these categories then rose to almost 9 of 10 respondents (with 62% 'very worried' and 27% 'somewhat worried' by this point)⁵⁹ although it should be noted there were differences in question wordings used between the 1988 and 1992 survey waves.

These studies, taken together, suggest that at the time climate change was coming to have a degree of political prominence toward the end of the 1980s on both sides of the Atlantic^{60, 61} levels of public awareness and concern were already reaching relatively high levels. Given the associations made with a range of other topics, this may however have been connected to a nonspecific growth in public environmentalism over previous decades⁶² as much as an appreciation of climate change *per se*.

Mid 1990s to Mid 2000s: Growth and Fluctuation in Concern

Whereas the 1980s and early 1990s were marked by a growth in basic awareness and concern about climate change worldwide, the period that followed entailed a sustained growth of public concern overall, but with this occurring alongside substantial international and intranational variation. The overall growth in concern mirrors a rise in media attention to climate change, in turn associated with growing scientific evidence and political attention.⁶³

In the United States, the extent to which the public report they personally 'worry' about climate change has risen and fallen several times since the late 1980s.²⁰ As shown in Figure 3, the remarkable volatility in this indicator of personal concern has been particularly evident since the late 1990s; we also

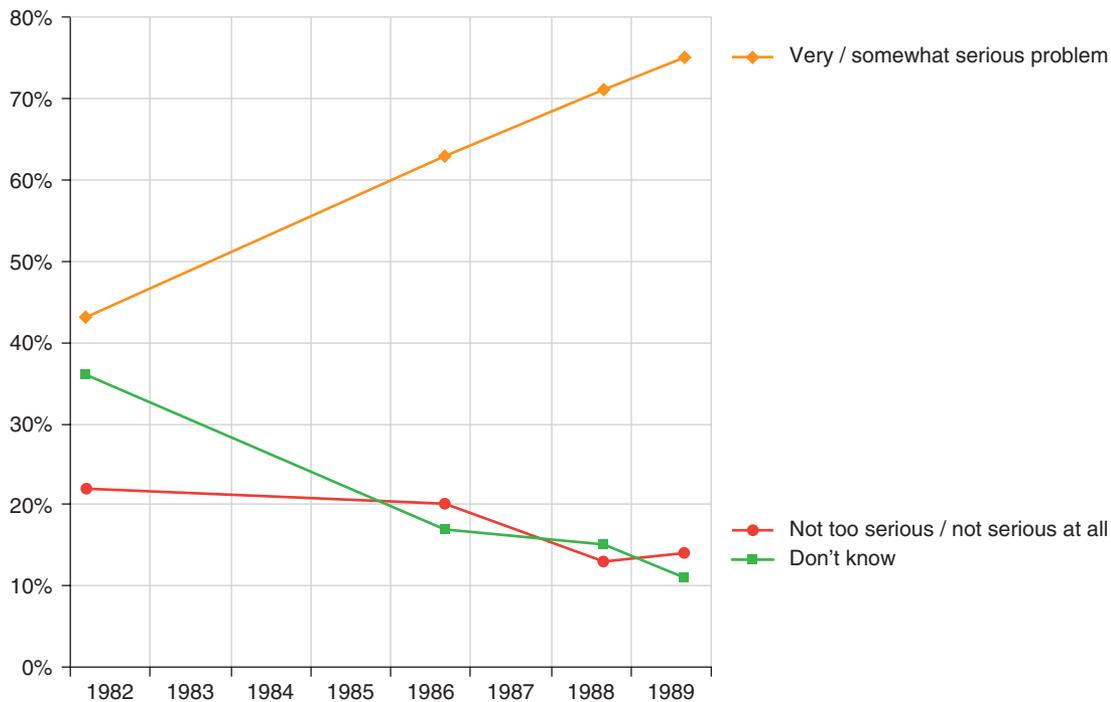


FIGURE 2 | Early trends in public perceptions in the United States. Data points show how ‘serious’ U.S. public survey respondents considered climate change to be during the 1980s. Data obtained from Ref. 58 ($n \geq 1000$ at each time-point).

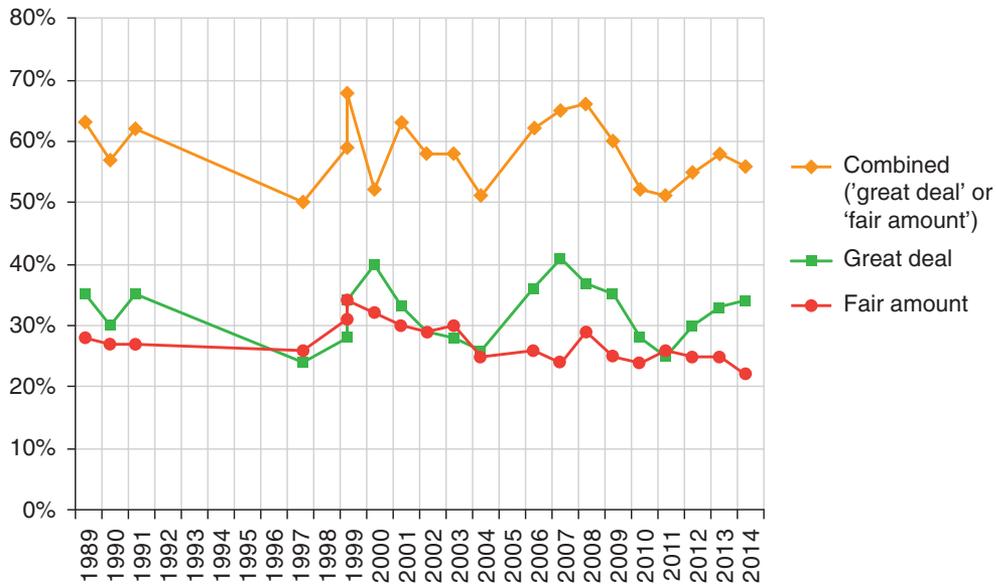


FIGURE 3 | Changing levels of ‘worry’ about climate change in the United States. Data points show the extent to which U.S. public survey respondents reported personally worrying about climate change over a 25-year period. Data combined from Refs 20 and 64 ($n \geq 1000$ at each time-point).

include here data showing continuing variation to the present time.^{20,64}

Despite the temporal variability in this measure, a review of more than 40 U.S. surveys focused on the early 2000s nevertheless concluded that the weight of public opinion in the period 2001–2004 strongly

favored U.S. participation in the Kyoto Protocol and decisive action on climate change, in direct contrast to national policy at this time.³¹ In 2004, e.g., nearly three-quarters (71%) of U.S. respondents supported the country’s participation in the Kyoto Protocol, with only 19% opposing.³¹

By the year 2007, support for substantial action to mitigate climate change was evident at the international level. Brechin³² has argued that data from several cross-national polls point to growing public concern about climate change worldwide in the 2000s, as well as to strong public support at this time for climate mitigation policies. Likewise, from a synthesis of eleven international polls conducted between 2003 and 2007, Kull et al.⁶⁵ argued that concern about climate change cross-nationally was by now widespread and growing, with large majorities acknowledging that human activities caused climate change, and supporting policies aimed at emissions reduction. For example, the proportion of publics across 14 countries viewing climate change as a 'very serious' problem increased between 2003 and 2006 (with only two further countries for which repeated measures data was available, India and Mexico, showing slight decreases in this measure over time).⁶⁶ Similar comparisons between 2000 and 2006 also show broad-based increase in international concern.⁶⁷ Likewise, a poll of 10 European countries carried out in both 2005 and 2007 showed a sharp rise in the percentage of respondents who considered it 'very likely' they would be personally affected by climate change—increasing from 36 to 55% over this time period.⁶⁸

Mid 2000s to Late 2000s: Increasing Skepticism and Polarization

In general, the interpretation placed by researchers upon polls up to the mid-2000s affirms a widespread increase in awareness among the public, and the establishment of a popular consensus for action on climate change, albeit against a backdrop of varying personal concern in some countries. Survey studies from the latter part of the 2000s and early 2010s have, by contrast, often emphasized the proliferation of public doubts and skepticism about climate change. Perhaps most surprisingly, given the growing scientific consensus on the basic reality and human contribution to climate change, have been indications in some parts of the world that publics have become less accepting of these matters. Although trends at this time do appear to indicate growing skepticism about climate change, it is nonetheless important to note that clear majorities in many countries still expressed high levels of concern and recognition of the problem throughout this period.³⁰

Between the years 2006 and 2009, a decline was observed in the proportion of U.S. citizens of the opinion that global temperatures were rising, and that weather patterns in their localities were changing—although a large majority did still

accept the former proposition.⁶⁹ Separate data likewise point to a sharp drop between 2008 and 2010 in the proportion of U.S. citizens who accepted climate change is happening, that it had an anthropogenic component, or that there was scientific consensus about its human causes.⁷⁰ During the mid- to late-2000s, related research found that the types of imagery people spontaneously associate with climate change moved progressively in a skeptical direction. Smith and Leiserowitz²⁶ carried out an analysis of responses to open-ended survey items which asked participants to state 'the first thought or image that comes to mind' in relation to climate change. Based on answers provided over four time-points, these authors showed that through the 2000s in the United States the extent to which climate change was associated with what they term 'naysayer' imagery increased dramatically. This imagery centered most prominently on associations with climate change as a conspiracy theory, together with denials of the existence of climate change and assertions that it was a natural phenomenon. Whilst 'naysayer' imagery accounted for less than 10% of responses in 2002, this rose to 23% in 2010.

Similar findings have been obtained elsewhere in the developed world. Across Europe as a whole, over three surveys conducted during 2008 and 2009, a decline in the perceived seriousness of climate change was observed.⁷¹ In Australia, an increasing tendency for survey respondents to view climate change as exaggerated and/or to denigrate policy designed to address it, was recorded across the 2008–2011 time period.^{72,c} Within Great Britain, too, survey findings from the mid-2000s pointed to an increase in public doubts about the basic reality of climate change. Whereas only 4% of people in 2005 were of the view that the world's climate is not changing, this had risen to more than one in seven people (15%) by 2010, with the perceived risk from climate change also decreasing over this time period.^{73,74} Separate research in England by Whitmarsh²⁵ drawing on survey data from 2003 and 2008 drew the conclusion that the most significant element of increasing public skepticism concerned the perception that the seriousness of climate change is exaggerated, with an almost doubling of this perception over the 5-year period. Likewise, Ratter et al.⁷⁵ point out the declines in several measures of public perception of risk from climate change in Hamburg, Germany, around this time. These authors note, e.g., that the proportion of respondents considering climate change to be a 'serious threat' dropped from 17% in 2008 to 9% in 2011.

Whilst the research described above was not designed to directly attribute reasons for increases in

skepticism over time, both the Smith and Leiserowitz, and Whitmarsh studies^{25,26} argued that a process of politicization of climate change was likely to have been a significant contributing factor. The former authors suggested that with the shift in political context in the United States following the election of Barak Obama, climate change came to constitute a 'litmus test', with conservative Republicans aligning with climate skeptic positions as a means of differentiating themselves from Democrats.

Other survey-based research would appear to empirically bear out the notion of growing polarization, particularly in the latter 2000s. McCright and Dunlap⁷⁶ demonstrate a statistically significant interaction between political orientation and survey year over the 2000s in the United States. These authors also point out that whilst political polarization with respect to people's views on climate change had already begun in the early 2000s, the division is increasingly evident between 2008 and 2010. Whereas in 2001 there was an 18% difference between liberals (67%) and conservatives (49%) concerning whether climate change had already begun to happen, this develops into a much larger 45-point difference by 2010, at which time 75% of liberals and 30% of conservatives were of this view.

Separate analyses affirm that polarization of the U.S. public's views on climate change gathered pace in the late 2000s.^{77–79} Brewer⁷⁸ observes that increasing partisan disparity occurred subsequent to Obama's election in 2008 on a survey indicator examining acceptance of the reality of climate change, although a widening gap was less clear for other measures examined. Guber⁷⁹ argues that U.S. citizens were more polarized on the topic of climate change in 2010 than at any other point in time, or on any of the other social, economic, and foreign policy topics considered in her analysis.

In addition to variability and polarization observed within the United States in particular, it is important to note that survey research also points to substantial heterogeneity in the ways public perspectives have changed over time at an international level.

The very broadest international trends across the late 2000s are illustrated by polling across 111 countries, carried out by Gallup in both 2007–2008 and 2010.⁸⁰ These data show that across this time period there were wide regional and global variations in public opinion trends, both with respect to the perceived risk arising from climate change, and the recognition of an anthropogenic component. In both the United States and Western Europe, sharp declines occurred between 2007/2008 and 2010 in the

proportion of respondents viewing climate change as either a 'somewhat serious' or 'very serious' threat to themselves or their family. By contrast, in Latin America and sub-Saharan Africa increasing proportions of people considered climate change to represent a threat in these terms—although the differences over time for these regions are relatively small and may be close to the margins of error for these survey data. Concerning the extent to which respondents saw climate change as being connected to human activities, again, declining proportions were of this view in the United States and Western Europe, whereas in parts of Africa, developing Asia, and Latin America, the human component to climate change was increasingly coming to be acknowledged.⁸⁰

Divergences in public opinion are also obtained on a country-by-country basis toward the end of the 2000s. Table 3 shows broad regional trends based on Gallup data between 2007/2008 and 2010 as described above, as well as from nations selected to illustrate both rising and falling public risk perception worldwide. Whilst it cannot be stated with certainty that the smaller changes shown in this Table are significant (e.g., a 2% change in risk perception for the Commonwealth of Independent States) these data can nevertheless be considered illustrative of the heterogeneity of trends occurring worldwide over this time period.

Separate research carried out by the Pew Research Center's 2007–2010 Global Attitudes Project⁸¹ has also concluded that there were pronounced variations cross-nationally at this time, with some nations reporting sharp increases—and others sharp decreases—in the percentages of people considering climate change to be a 'very serious' problem. Reasons for such international variations and diverging trends in opinion are little understood and complex, although clearly aspects of the surrounding physical and social contexts are important, including levels of risk exposure, cultural values, political context, and the nature of media coverage. With respect to the growth in concern in Latin America in the late 2000s,⁸⁰ this may be related to a growth in climate justice activism linked to left-wing political activism at this time, as well as to the occurrence of extreme weather events.^{82,83} Conversely, recent analyses have argued that in the United States and other Anglophone countries, right-wing think tanks and media outlets have been key players in a 'conservative counter-movement' that has emerged to challenge climate policy.^{84–87} We consider studies that have carried out empirical analyses of the influence of such political factors on changing public opinion in a subsequent section of the review.

TABLE 3 | Proportions of Survey Respondents Considering Climate Change to be a 'Threat'

Region or Country	% Considering Climate Change to be a Threat		
	2007–2008	2010	Change
Latin America	67	73	+6
Sub-Saharan Africa	29	34	+5
Commonwealth of Independent States	42	44	+2
Developing Asia	31	31	0
Middle East & North Africa	42	37	−5
Developed Asia	79	74	−5
Eastern/Southern Europe	67	60	−7
USA	63	53	−10
Western Europe	66	56	−10
World average	41	42	+1
Mongolia	30	54	+24
Philippines	42	60	+18
Ecuador	69	85	+16
Uganda	30	45	+15
Morocco	29	41	+12
Haiti	35	18	−17
Sudan	42	26	−16
France	75	59	−16
Czech Republic	39	28	−11
United States	63	53	−10

Data obtained from Ref 80.

Late 2000s to the Early 2010s: A New Phase for Public Perceptions?

Cross-national divergences in public opinion trends appear to be continuing to the present time. Nevertheless, there are signs that in some parts of the world public concern about climate change is stabilizing and in some cases increasing.

Surveys undertaken across the 28 member states of the EU between 2009 and 2013 suggest that the relative importance of climate change has remained largely consistent over this more recent time period.⁸⁸ At each of three time-points (2009, 2011, and 2013) between 16 and 20% of respondents considered climate change to be the single most serious problem facing the world as a whole. When permitted to select more than one area of concern, around a half of respondents consistently considered climate change to be among the most serious problems facing the world in each of the 2009–2013 surveys.⁸⁸

There have been less consistent trends at an international scale over this time period. Globescan data appear to show that at an aggregate, global level, concern has continued to decrease since 2009.⁸⁹ Disaggregated by country, however, these data suggest that whereas concern in many developed countries (UK, USA, Canada, and France) has stabilized during the 2010s, the trends for developing countries have been more mixed, with some countries (e.g., China, Mexico, and Kenya) seeing falls in public concern.⁹⁰ Separate survey data from Britain available to 2013⁹¹ suggest that the proportion of people expressing concern about climate change has continued to decline over this period, however. Compared to 82% expressing concern in 2005, and 71% in 2010, only 60% did so by 2013. In Britain, doubts about the reality of climate change have likewise continued to increase, with almost one in five (19%) of respondents doubting its existence in 2013, compared to only 9% in 2005.⁹¹

Some U.S. polls appear to point to a halt in the downward trend on a number of indicators, and suggest that climate change may be returning to the public agenda. Data from the Pew Research Center show that the proportion of the U.S. public of the view that there is 'solid evidence' that the Earth is warming has increased steadily from a low point of 57% around 2009 to 67% by October 2013.⁹² Similarly, the proportion of people stating that human activity is the main cause of climate change has risen from 36 to 44% over the same period, a trend observed among Republican as well as Democrat voters.⁹² Separate polling data to 2014 further show a steady growth in the proportion of Americans of the view that climate change has a human cause from 2010 onward, which is again observed among both Democrat and Republican voters.⁹³ This is accompanied by an increase in the number of people worrying 'a great deal' about global warming from 25% in 2011 to 34% in 2014 (see Figure 3). Other research in the United States suggests more modest increases in acceptance and concern about climate change, however. The Yale Project on Climate Change Communication reports that more U.S. respondents accept that climate change is happening in 2014 (64%) than in early 2010 (57%), a difference that is only slightly larger than the margins of error of the surveys; furthermore this figure remains lower than that obtained by this project toward the end of the 2000s.⁹⁴ Similarly, the proportion of respondents who report being 'worried' about climate change, whilst largely stable over the 2010s to the most recent data point in 2014, is nevertheless lower than that obtained by this project in the late 2000s.⁹⁴

It is unclear, and would be unwise to speculate, as to the likely direction of future trends in these

types of polling data. It may tentatively be concluded from the more recent evidence available, however, that the declines in some measures observed in the 2000s appear to have slowed in the United States and Europe as a whole, although this pattern is not observed in many major developing countries. Research attention is now required to examine prospective trends and patterns in public perceptions across multiple regions, with a view to understanding how and why these develop in the coming years.

Time Series Analyses and Studies Examining Drivers of Change (Study Type 3)

The trends described above can plausibly be accounted for by a range of factors. Particularly with respect to the declines in public concern observed during the second part of the 2000s, contributory factors may include cycles of media and political attention, deliberate attempts by some actors actively to undermine climate science, and a wider politicization of climate change with the associated public distrust this brings.³⁰ One prominent theoretical explanation has been that people only have a 'finite pool of worry' available and that where other pressing concerns—such as the implications arising from the financial crisis of 2008—dominate, then these may diminish the attention paid to climate change.⁹⁵

Given the variety of possible explanations for changing public perceptions, analyses which utilize longitudinal data to directly examine the underlying reasons for changes in public perceptions are particularly valuable. Studies of this sort can be divided into three types, each of which we consider below: (1) measurement of public perceptions of climate change before and after the occurrence of significant events (five studies); (2) time-sensitive analyses of the relationships between meteorological data (e.g., temperature) and public perceptions (four studies); and (3) time series analyses that use data from several time-points to test the relationships between socioeconomic variables and attitudes toward climate change (three studies).

Public Opinion Before and After Significant Events

Directly prior to the Kyoto conference in 1997 and the signing of the Kyoto Protocol to limit international greenhouse gas emissions, a substantial effort was made by the Clinton administration in the United States to build public support for action on climate change, leading to what Krosnick et al. describe as a 'major national debate' on the subject.⁹⁶ In order to ascertain whether the heightened media attention and

changed political landscape at the time had affected Americans' beliefs and attitudes toward climate change, these authors administered a survey in two waves, the first in September/October 1997 and the second between December 1997 and February 1998. This study found that among the U.S. public as a whole, and indeed among those for whom climate change was a personally salient topic, attitudes were largely unaffected by the 1997 debate. However, evidence was obtained that the debate did have a polarizing effect, whereby Democratic respondents moved in favor of action on climate change and on a range of other measures (in line with the Clinton administration's position) at the same time as Republican respondents moved in the opposite direction. These findings are in line with the longer-term polling studies outlined above showing polarization of opinion in the United States,^{76–79} and furthermore underline how key national events such as the attention in late 1997 to climate change in the context of the Kyoto Protocol can trigger shifts in public opinion in opposing directions.

A rather different form of communication around climate change occurred with the release of the 2004 film *The Day After Tomorrow*, in which a major environmental disaster occurs as a consequence of climate change. As Leiserowitz et al.⁹⁷ show, this film generated more than 10 times the media coverage in the United States of the 2001 IPCC report. Because of these factors, as well as the large number of people who viewed the film (around 30 million in the United States), we include consideration of this study here as a national 'event' which had the potential to affect public opinion on a large scale. Using a quasi-experimental design, Leiserowitz et al. argued that for those who viewed the film, attitudes toward climate change had altered (e.g., they reported more concern about climate change, and more pro-environmental behavioral intentions). Based on nationally representative surveys undertaken immediately before and after the release of the film, the study nevertheless concludes that *The Day After Tomorrow* was not itself influential enough to have significantly altered U.S. public opinion at a national scale.

Another putative influence on public opinion was the so-called 'Climategate' affair of late 2009, in which emails obtained from the University of East Anglia's Climate Research Unit (CRU) generated extensive skeptical commentary about the science of climate change. This has been widely perceived as a particularly damaging episode for public trust in climate science.^{98,99} However, despite there being extensive consideration in the research literature of the implications of 'Climategate' for the

conduct and representation of climate science (e.g., see Grundmann⁹⁹), there has to our knowledge been only one published study which has directly examined the impact of this episode on public opinion (although see Anderegg and Goldsmith¹⁰⁰ for a discussion of its impact on internet search terms as an indicator of issue salience).

Drawing on data gathered in 2008 and then in 2010, Leiserowitz et al.¹⁰¹ measured respondents' belief in the reality and human causation of climate change, degree of personal concern, and trust in information sources. The 2010 survey was carried out around 2 months after the CRU e-mails were first posted online and 1 month after the story had appeared in mainstream media. In addition to replicating items from the 2008 survey, this second survey also asked a series of questions about respondents' recall of, and attitudes toward, the 'Climategate' episode. Over this time period, these authors found there had been sharp declines in several attitudinal measures, including trust in climate scientists. They argued furthermore that this could be directly connected to people's degree of exposure to the story. In line with the studies of opinion polarization described above, this effect was, however, largely confined to those who were already predisposed to skepticism about climate change, whether measured by political orientation (Republicans) or worldview (Individualists).

A limitation of the 'Climategate' study described above is its reliance on self-report (respondents indicated the extent to which they were aware of the story). As such, it is possible that those reporting attention to this news story were also those already less trusting of climate science. The study authors indeed acknowledge that a 'perfect storm' of other major events around this time (including the worldwide economic recession and shifts in the political landscape) may have contributed to a wider social attenuation of risk around climate change, and broader changes in public attitudes.¹⁰¹ It is also worth noting that a separate UK poll commissioned for the BBC in early 2010 showed that, among those who stated they had heard news stories 'about flaws or weaknesses in the science of climate change', there was no evidence that this media attention had led to more people reporting reduced levels of conviction about the risks of climate change, than reported higher levels of conviction as a result.¹⁰²

Research examining public perceptions of climate change has often been carried out in conjunction with that examining perceptions of other environmental and technological risks as well as attitudes toward energy policy, not least due to the fact that nuclear power has in more recent years been presented as a

low-carbon technology able to contribute to climate change mitigation.¹⁰³ Following the disaster that occurred at the Fukushima nuclear power complex in Japan in March 2011, two separate studies have examined whether there were subsequent shifts in public attitudes toward climate change, as well as toward nuclear power. Bird et al.¹⁰⁴ found that public concern about climate change in Australia reduced following the accident, at the same time as public support for nuclear power declined. Poortinga et al.¹⁰⁵ also observed changes in public attitudes toward climate change in the UK (this study drew on some of the same measures reported in Spence et al.⁷⁴). In Japan, however, public acceptance of the reality of climate change was as high after Fukushima as before—suggesting that, whilst the accident had affected Japanese attitudes to nuclear power, this did not extend to attitudes to climate change.

The two studies described above showed that UK and Australian attitudes toward climate change altered in the wake of Fukushima, although neither claimed that this demonstrates that the accident was the direct cause of this. Bird et al. did suggest that relative risk perceptions (whether nuclear power was seen as 'worse' than climate change) may have been affected. However, as Poortinga et al. argued, the trends observed in these studies were instead likely to have been connected to other factors influencing public opinion at the time, such as structural economic conditions.

The Role of Weather Conditions and Events

At the time of rising public skepticism in the late 2000s, some commentators suggested that this could be connected to the unusually cold weather in Europe and the United States.^{106,107} Albeit that there are important distinctions between the two concepts, 'weather' is strongly associated with 'climate' by nonexperts³⁷ and current temperature may be used (consciously or not) to draw conclusions about the validity of climate change. People's perceptions of temperature anomalies (e.g., whether they are of the view that recent weather has been 'warmer' or 'colder' than usual) can also affect beliefs.^{108–110} It is thus plausible that changing meteorological conditions may influence aggregate public perceptions over time.

Here, we consider four studies that have examined changes in public perceptions in light of varying weather conditions—each of these was conducted in the United States. For the purposes of this review, we only consider studies that have collected public perceptions data at more than one time-point, and related these to temperature and/or other weather data. These studies represent a subset of a larger body of work

TABLE 4 | Studies Considering Role of Weather in Changing Perceptions

Study Citation	Time Period	Findings
Deryugina (2013) ¹¹³	2003–2010	Short-term temperature fluctuations have no effect; longer-term (1 month to 1 year) changes predict climate change beliefs among conservative voters
Donner and McDaniels (2013) ¹¹²	1990–2010	Temperature anomalies over previous 3–12 months predict level of concern, and beliefs about climate change
Egan and Mullin (2012) ¹¹⁵	2006–2008	Weather anomalies predict climate change beliefs although this effect decays rapidly
Hamilton and Stampone (2013) ¹¹⁴	2010–2012	Recent temperature anomalies predict belief in human causation of climate change among unaligned voters

Analyses for each of the four studies are based on U.S. data.

examining public perceptions of weather and weather events (e.g., see Reser¹¹¹). The studies we consider are summarized in Table 4.

Drawing on data from national weather station observations, Donner and McDaniels¹¹² examined the extent to which these corresponded with public opinion data over the period 1990–2010. These authors found that attitudes toward the reality of climate change, and degree of personal concern, were both strongly related to temperature anomalies over the past 12 months—with both attitudinal measures being lower in the context of colder than usual temperatures, and higher for warmer periods.

Also utilizing weather station data, this time over the period 2003–2010, Deryugina¹¹³ found that where temperature deviates from the mean over a short time period of up to 2 weeks prior to survey completion, this did not affect people's beliefs. However, more sustained periods of anomalous warm weather did affect the likelihood that respondents would be of the opinion that climate change had already begun to happen—with colder weather having the opposite effect. Interestingly, Deryugina obtained this effect only for Conservative voters, although did acknowledge that this may have been an artifact of the study design. Separate work by Hamilton and Stampone¹¹⁴ by contrast observed an effect of temperature anomaly on perceptions across political orientations, although

this effect was strongest for voters describing themselves as 'Independent'. Again in contrast to Deryugina's study, which found that longer-term anomalies were more important in altering perceptions, this research found that the effect of temperature anomaly was strongest the closer in time that this occurred to survey completion.

A finding that temperature anomalies can influence perceptions but that this effect decays rapidly was obtained by Egan and Mullin.¹¹⁵ These authors used as their outcome variable responses to a statement asking whether or not there was 'solid evidence' that the Earth was getting warmer. Again, these authors observed that deviations in local temperature affected belief in the reality of climate change. However, this was found to occur as a function of the absolute size of the deviation from mean temperature—in contrast to the finding by Deryugina¹¹³ that warmer and colder weather had contrasting effects on beliefs. Egan and Mullin also argued that the effect of weather variation was, in itself, particularly pronounced—comparable in importance, they argued, to those identified in the political science literature of boosts in campaign advertising on voting intentions. Nevertheless, they also conclude that, under normal circumstances, the weather's effect on opinion is 'fleeting'.

These results, taken together, suggest that long-term temperature anomalies have a robust effect on public perceptions of climate change. Because of the contrasting findings obtained with respect to the timescale at which these effects occur, it nevertheless remains unclear whether the influence of the weather on public opinion is most pronounced for immediate or for longer-term conditions. It also remains unclear whether such effects are short-lived or have the potential to endure over a sustained period. A further research need concerns assessment of the influence of discrete extreme weather events on long-term public opinion. Whilst there is a growing body of literature that examines individuals' perceptions of climate change in response to events such as flooding and hurricanes^{111,116–119} it remains unclear the extent to which this may have effects at the population level.

Sociopolitical, Economic, and Environmental Drivers of Change

All the research considered in the review thus far has offered insights into patterns and trends in public perceptions of climate change over time; and in the previous sections we considered evidence of the role of one-off events in shaping public perceptions, as well as the role of changing meteorological conditions. Nevertheless, the question of which factors are most important in driving the shifts in attitudes

identified has rarely been directly addressed in the literature. This is problematic because, as we have suggested, there are a wide range of possible explanations available for changing perceptions of climate change. Without direct assessment and comparison of socioeconomic and other factors as influences on changing public opinion, there is a risk that such phenomena as the widely documented increases in public skepticism in the late 2000s come to be associated with plausible-seeming, but untested rationalizations. For example, there has been a widespread tendency to attribute a major impact on public opinion to the 'Climategate' episode,¹²⁰ but with the exception of the work we cite above¹⁰¹ there is very little evidence available to support this.¹²¹ Indeed, public concern about climate change in the United States and UK had already begun to decline prior to the controversy generated by this story, with multiple other factors of potential relevance salient around this time. As we note above, there has been a tendency in some quarters for changes over time in polling data to be overinterpreted or undue inferences made about the factors behind shifts in public opinion. Those studies which have attempted to empirically examine the causes of changing public perceptions of climate change are, therefore, of particular value.

One study by Scruggs and Benegal¹²² that set out to assess the reasons behind the increase in public doubts about climate change in the late 2000s, compared the influence on public opinion of skeptical media coverage, short-term weather anomalies, and economic circumstances—these latter in the form of unemployment data and an index of consumer confidence.

This study was able to analyze the effects of each of these on aggregate public opinion in both the United States and Europe, as well as to look more closely at the effects of unemployment and weather anomalies at the subnational level in the United States through matching individual-level responses to locally relevant indicators. These authors' analysis concluded that an economic account—contextualized to the recessions experienced in many countries in the late 2000s—most convincingly explained declines in public concern and acceptance of the reality of climate change, both in the United States and Europe, at national as well as local level. As part of these findings, they observed that within Europe, there was a very strong association between increases in employment rates and increases in skeptical opinion on a country-by-country basis. Whilst the study obtained modest significant effects for temperature variations upon public opinion, these were much smaller in comparison to economic effects.

A second study by Shum¹²³ largely bears out these findings in the European context. This research drew on the same European dataset as Scruggs and Benegal¹²² to gauge public attitudes concerning the perceived seriousness of climate change, although made use of this in a different manner. Shum's study also applied figures for economic growth as an economic indicator, together with mean temperatures in the month of August preceding each of three survey waves from 2007 to 2009. This study concluded that changes in quarterly GDP growth rates affected attitudes toward climate change at both national and European levels. The effect of summer temperatures was limited to an aggregate European level (i.e., in warmer years, the European public as a whole expressed more concern), but the authors acknowledged the limitation of this inference and pointed out that where analyzed at national level, temperatures were not influential. A further important observation was that, controlling for income levels, those countries in the 'old Europe' of the West showed decreased concern over time, in comparison to those countries in the East where this effect was less pronounced. From this, Shum makes the prediction that should incomes in the East of Europe continue to increase, they can be expected to become among the more concerned countries with respect to climate change.

From these two analyses, an economic explanation for declines in concern is most apposite. This is consistent with the 'finite pool of worry' hypothesis⁹⁵ which predicts that concern about one issue—climate change—will decrease as concern about another—in this case, economic circumstances—becomes more salient.

Although it would appear that the economic downturn has played a part in changing public opinion, it is important to note that the studies considered above were only able to test this hypothesis against a limited number of competing explanations (media reporting and temperature variation). A further factor argued to have been important in effecting public skepticism has been the role of social factors involved in promoting climate change denial, such as conservative think-tanks, media outlets and politicians, and sections of the media.^{84–86} Conversely, it might be expected that advocacy in favor of action on climate change could raise public concern.

One of the most comprehensive analyses of the multiple possible influences on public opinion, which incorporated an assessment of such political 'cues' was carried out by Brulle et al.¹²⁴ in the United States. This study used a large number of measures designed to capture and distinguish between the effects of extreme weather events, mass media coverage and

more direct media advocacy of pro/anti positions on climate change, dissemination of scientific information, and ‘elite cues’—the last of these being gauged by Congressional statements, voting patterns and hearings with respect to climate change.

Brulle et al. concluded from their analysis that three major factors affected levels of public concern about climate change over the 2002–2010 period. They observed, first, that the quantity of media coverage—itsself an indirect measure of the importance ascribed to climate change as a topic—translated into public concern. Secondly, and in line with the studies described above concerning the influence of economic factors on public opinion, they found that economic factors (unemployment and economic growth) were influential—and furthermore that U.S. war deaths in Iraq and Afghanistan significantly decreased public concern. These influences they attribute to society having a limited amount of ‘issue space’, analogous at a societal scale to the idea of a finite pool of worry whereby other issues compete with climate change for the public’s attention. The study found however that the most important influence on public concern about climate change was elite political cues, both originating from Democratic and Republican sources, which led to heightening and diminishing of concern respectively.

Whilst these results clearly demonstrate the importance of political impetus both for constraining and motivating public concern, it is important to note that there are likely to be complex interrelations between many of the social forces considered. For example, the publication of the Fourth IPCC Assessment Report may have galvanized support among some politicians for action; in addition, and as Brulle et al. point out, media reporting of climate change is itself affected by economic circumstances and attention paid to climate change by prominent politicians. It should also be noted that there may be particular effects at play in the United States that do not operate the same way in other parts of the world. This is not least because the U.S. debate on climate change appears to be particularly politicized, with analyses showing that media reporting and wider discussion of climate change occurs in a very different manner elsewhere^{125–127}—e.g., Billett¹²⁸ concludes that the press in India ‘entirely endorses climate change as a scientific reality’.

Qualitative Studies with a Longitudinal Component (Study Type 4)

As both Pidgeon^{30,129} and Wolf and Moser¹³⁰ point out, qualitative approaches provide the potential for

considerable added value over quantitative surveys, providing far greater depth of explanation and insight into people’s perspectives on climate change, including the complexity of their cognitive and emotional engagement with the issues involved. Much anthropological research considering people’s understanding of and responses to climate change entails engagement with communities over a sustained period of time, and many such studies have noted that research participants assert the view that the weather and other factors in their locality have changed over time.^{131,132} However, despite the growing body of research utilizing qualitative methodologies to understand the human dimensions of climate change^{130,133,134} it is often unclear from such studies how people’s perceptions of climate change have, in themselves, changed over the years. Here we consider five studies which have included a focus on changing public perceptions, using qualitative data.

One exceptional study by Paerregaard¹³⁵ considered the development of climate change perceptions over a 27-year period in a traditional community in the Peruvian Andes. This research achieves such a comparison over time by drawing on long-term ethnographic field data dating back to repeated visits to southern Peru in 1986, 1990, and 1993—as well as recent comparative data obtained in 2011. In contrast to many of the studies considered in this review, Paerregaard states that an explicit aim of this work is to explore perceptions of climate change among people ‘living on the margins of the global world’.

Among many socioeconomic and cultural changes observed in this region of study, was the finding that changes in ritual practices were intimately connected with changes in the ways in which environmental change—including climate change—was conceptualized. Whereas in the 1980s and early 1990s the vast majority of villagers in the region continued to participate in ritual practices, such as making offerings to mountain deities, in return fieldwork in 2011 a growing number of people had grown doubtful about the effectiveness of offerings and rituals. Such shifts in practice and attitudes were in turn related to people’s experience of climate change as one of many external forces impacting on their locality. In part because of their experience of changing temperature and water availability, however, Paerregaard notes that study participants had by 2011 begun to employ ‘a new terminology to observe and interpret environmental change’ and that they ‘talked of the climate as a phenomenon posing serious threats to their lives’. Notwithstanding the emergence of climate change as a meaningful concept for the people in this region, this author points out that the way in which it was

understood nevertheless remained distinct in many ways from a typical Western conceptualization.

The above study is pertinent for drawing attention to the fact that shifts in understanding of climate change do not happen in isolation but rather as part of a pattern of unfolding social changes in conjunction with changes to physical conditions. Lavrillier¹³⁶ has likewise observed that changes in values and attitudes have occurred in concert with the manifestations of climate change among the Tungus of Siberia. As this author notes, climate change has led both to outlooks which may be considered positive and adaptive, but also to a fear of future impacts and challenges to traditional beliefs and narratives (p. 269):

For the present time, they are ... expressing the strong confidence they have in their ability to adapt. On the contrary, for the future, their narratives and rituals express a dread at the thought of being endangered and a mutation in some perceptions of the environment. Previously held to be eternally renewable, the environment is now seen as likely to disappear.

Crate^{137,138} has also reflected upon how the perceptions of another population in Siberia—in this case the Viliui Sakha of northeastern Siberia—have changed over time in the context of climate change. Having carried out research with these communities since 1991, writing in 2011 Crate¹³⁷ commented that it is only in the past few years that her research participants have started to express concern about changing weather patterns and the timing of seasons, as well as changes to land formations such as permafrost.

A further study by Capstick¹³⁹ carried out in the UK examined changing public perceptions of climate change over the period 1997–2010 through comparative analysis of six separate qualitative datasets (focus group and interview studies) obtained over this time period. This research found substantial continuity over time in the ways in which public participants expressed their viewpoints across a series of discourses encompassing the personal, social, and scientific aspects of climate change. Capstick argued however that several key changes were evident over time in how people understood climate change. Whilst earlier research participants tended to see the scientific aspects of climate change as undecided or yet-proven, there was an increasing tendency toward later years for climate science to be characterized as representing opposing positions or ‘sides’ indicative of scientific dispute. In the personal domain, people’s accounts of their own climate-relevant behavior displayed an increasingly moralized character over time. This was also reflected in changing views about wider practices such as energy-saving and recycling, which were seen

as becoming increasingly routine and normalized over the period of analysis. A further finding of this study was that expressions of ‘fatigue’ around climate change appeared to be a recent development, with instances of this found only in the 2010 data.

Whilst the studies described above have adopted disparate methodologies to explore the perceptions of very different research populations, they nevertheless point to the possibility of developing insights into changing public perceptions of climate change that take into account people’s shifting values, practices, and wider cultural contexts. These findings are of a different character to those obtained from quantitative, usually survey-based, studies that for the most part dominate the present review. However, such work offers some clues as to how changing perceptions of climate change may occur in concert with changing physical and social conditions which are specific to particular communities.

CONCLUSIONS

Understanding popular opinion on climate change and support for measures to address it is critically important given the need for profound societal changes associated with mitigation and adaptation. Our systematic review has drawn on diverse quantitative and qualitative evidence from a range of countries over the past quarter century, to demonstrate the growth—and subsequent fluctuations—in climate change awareness and concern since the issue emerged into the public consciousness in the 1980s. After a period of rising concern to around 2007, polls show a sharp decline in belief and concern across many developed countries, followed by stabilization in some parts of the world since about 2010. While experiences of anomalous weather and other events (e.g., *The Day after Tomorrow*; Fukushima; Climategate) appear to have exerted some influence on public perceptions (or, most often, perceptions of a sub-group of the population), time series analyses that take into account a range of possible explanatory factors (e.g., weather, socioeconomic factors, and political actions) indicate the economic downturn and political events have been particularly influential.

Polling studies also reveal important variations both within and between countries in these longitudinal trends. Notably, there has been growing political polarization in the United States, with right-of-center voters growing increasingly skeptical, compared to left-of-center voters. This is consistent with pervasive ‘confirmation bias’ (the propensity to seek out and believe information that confirms existing views¹⁴⁰) and interest-based efforts to shape public

opinion.^{84,86,87} Between countries, parts of Europe such as the UK, and Australia and the United States, appear to have seen a much larger growth in skepticism than other regions, such as sub-Saharan Africa and South America, where concern about climate change has tended to increase.

Recent analysis⁸⁵ finds that media coverage containing skeptical voices is much higher in the United States and UK than Brazil, China, France, or India; and that right-leaning newspapers tend to feature more uncontested skeptical sources in their opinion pages. This reinforces previous U.S. analysis that shows right-wing think tanks are key players in a conservative counter-movement that has emerged to challenge climate policy.^{84,86,87} Coupled with a particularly polarized political system and influential fossil fuel industry interests, this may help explain the unusually high levels of skepticism in the United States.

Although analyses to date point to a role for economic and political factors in particular as influences on public perceptions, other factors may also have affected the identified trends. Some of the more sophisticated analyses identified in this review have inferred causality based on evaluation of multiple datasets, however these have been limited to extant data and the assessment of factors which can be straightforwardly operationalized. There are several other plausible influences on changing public perceptions, particularly in the context of growing skepticism in some parts of the world. However, there has been little or no formal analysis of how these may have affected public opinion. Such influences include the role of climate 'fatigue' (the sense that publics may have lost interest in the topic, or that it has become an 'old story'^{139,141–144}); the possibility that areas of genuine uncertainty in climate science have come to be conflated with aspects about which there is clearer consensus (that Spence et al. term 'uncertainty transfer'¹⁴⁵); a role for individual and collective denial;^{146–148} and a deleterious effect on public attitudes due to climate change seen increasingly as a political rather than scientific topic.³

Around the time that several polls indicate diminishing engagement with climate change, the highly publicised Conference of the Parties (COP15) took place in Copenhagen, prior to which there were extensive expectations of international political action on climate change. That these went largely unfulfilled, with climate change subsequently receding from the public and political agenda, likely contributed to the social attenuation of climate change as a risk.^{14,30} This may have been further compounded by extreme cold weather events in the northern hemisphere,

given the potential for colder temperatures to reduce belief and concern about climate change under some circumstances.¹⁰⁸ Fluctuations in public attitudes may also be connected to the sorts of issue-attention cycles evidenced in coverage of climate change by the media.^{60,149–151} Again though, to our knowledge, there has yet been no formal analysis of such cyclicality in public attitudes toward climate change.

Whilst the research literature has often focused on declining public concern in the late 2000s in developed countries, there has been far less attention paid to the reasons behind *growing* levels of concern in other regions. Whereas international comparative polling shows drops in public concern in the United States and Western Europe, the reverse trend is evident in parts of Latin America and sub-Saharan Africa. The reasons for this are far from clear, and warrant further research attention. Although much is now known about public perceptions in developed countries, the considerable variation in attitudes in many other parts of the world requires attention to a variety of localized contextual factors.^{129,152} For example, it would be valuable in future to follow-up cross-sectional survey research such as Leiserowitz and Thaker's detailed study of climate change perceptions in India,¹⁵³ to ascertain whether and how public attitudes are changing over time and at a regional level.

The nature of the evidence base has also developed over the timeframe that we have considered. From the earliest small-scale studies of public 'understanding', which often focused on disparity with expert knowledge, the number and type of studies has burgeoned to many hundreds of regional, national and international polls, longitudinal time series, and qualitative analyses. At the same time, the focus of these studies has expanded beyond a focus on public knowledge (or lack of it) to diverse measures of attitudes and beliefs (including skepticism), perceived risk and responsibility, willingness to adopt behavioral measures, policy support, and so on. Yet, as we indicate in Table 1, the literature concerning trends in public perceptions is characterized by key strengths and limitations, both with respect to the geographical location of data collection and analytic approaches employed.

First, and as we note above, there exists a substantial bias toward longitudinal studies of public perceptions in developed nations. This is understandable given the greater availability of research resources in these parts of the world, but leaves us largely in ignorance about how public understanding may have developed—and may be in the process of unfolding—in other places. It is important to appreciate changing public attitudes in the United States,

given the scale of its political influence in climate negotiations, as well as national and per capita carbon footprints. However, as the economies of Asia and South America continue to develop, and as climate impacts continue to be felt around the globe, there is a need to understand in some detail the temporal progression of public perceptions globally. Further detailed cross-cultural research is therefore required on the multiple socioeconomic, geographical, political, and psychological factors which may underpin changing public perceptions in key regions of the world.^{30,32,67,129}

A second, general limitation on much of the research conducted to date concerns the validity and idiosyncrasies of survey measures employed. Whereas survey respondents are typically asked about such matters as the perceived 'seriousness' or level of 'concern' about climate change, these are only some of the possible approaches to conceptualizing public attitudes. Indeed, the argument that climate change is considered of lesser importance relative to many other issues has been shown to be highly conditional on the exact survey question wording used, with one particular question formulation leading to climate change being rated more important than all other social issues presented.¹⁵⁴ Likewise, whether study participants are asked about 'global warming' or 'climate change' has been shown to significantly affect the types of responses obtained.^{37–39} Add to this the methodological challenges concerning cross-cultural research (not least equivalency in concepts between languages) and it becomes clear that there is substantial scope for developing this field.

Third, whilst there are numerous studies that have considered public perceptions data over time, there are very few which have applied the advanced statistical techniques necessary to differentiate between multiple causal factors influencing attitudes toward climate change. To this end, further work which adopts and extends the analytic approaches employed thus far^{122–124} and in an international context, would lead to a significant strengthening of the field.

Related to this, many of the analyses which have been carried out to date—including a large number of the studies considered in the present review—have been premised on individualistic assumptions about the formation of public opinion on climate change; for example, those studies which have drawn conclusions about attitudes based on the measurement of psychological and/or experiential factors. Whilst these types of analyses are useful for explaining the determinants of, and variability in public perceptions, they are however unable to account for movements

in aggregate opinion over time which are influenced by broader sociocultural and political factors.³⁵ Particularly for areas of policy which are aligned to a liberal-conservative continuum—which, studies have repeatedly shown, is the case for climate change—it has been argued that a collective level analysis is more appropriate for understanding changes in public opinion over time.^{35,155,156} Although often drawing on similar types of data such as public surveys, the assumptions and analytic approaches used in such macro-level analysis instead construe public opinion as being determined by broader 'general dispositions' or policy 'moods' which may change slowly, and/or in a cyclical manner.¹⁵⁶

Avenues for future work include bringing together these distinct disciplinary perspectives, not only to elucidate public opinion and responses through different methods and measures, but also to examine and challenge the assumptions and limitations inherent in these different paradigms. For example, public opinion polls are often used to construct the public in certain ways (e.g., as apathetic or ignorant) that serve to close down debate and delimit the role citizens can play in responding to climate change (e.g., as consumers rather than citizens).¹⁵⁷ More individualistic research framings of the public are also problematic as they can serve to direct responsibility onto individuals for addressing matters that require collective or policy responses,^{158,159} and may limit options for societal innovation whilst reinforcing preferred policy options.¹⁶⁰ Similarly, studies of public attitudes may be underpinned by an assumption that there is a simplistic relationship between climate-relevant individual behavior (e.g., energy use) and climate change beliefs, or that individual-level responses are the only level at which domestic emissions can appropriately be addressed, both of which are problematic assumptions.^{2,160,161}

Finally, further research is needed to elucidate how public opinion about climate change is culturally and dynamically shaped over time. Of particular value would be greater deployment of qualitative approaches to address this question, enabling the depth of insights attainable from such methods to shed light on such processes, whether via anthropological/ethnographic methodology^{162,163} or through the use of qualitative longitudinal techniques.^{164,165}

NOTES

^a The search term was structured to return any articles in which the phrase 'climate change' and/or 'global warming' was included in the article title or topic area, in addition to one or more of the terms 'public

opinion', 'opinion poll', 'attitude', 'perception', and 'skepticism' (and variants thereof). The search was performed on April 22, 2014.

^b The survey item relating to whether climate change had already begun to happen was only asked of those

survey participants who said they had at least some understanding of climate change.

^c This finding is based on a thematic analysis of a small number of responses to an open-ended question, and so may not be statistically significant.

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