

Participating in a climate prediction market increases concern about global warming

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Modifying attitudes and behaviours related to climate change is difficult. Attempts to offer information, appeal to values and norms or enact policies have shown limited success. Here we examine whether participation in a climate prediction market can shift attitudes by having the market act as a non-partisan adjudicator and by prompting participants to put their ‘money where their mouth is’. Across two field studies, we show that betting on climate events alters: (1) participants’ concern about climate change, (2) support for remedial climate action and (3) knowledge about climate issues. While the effects were dependent on participants’ betting performance in Study 1, they were independent of betting outcomes in Study 2. Overall, our findings suggest that climate prediction markets could offer a promising path to changing people’s climate-related attitudes and behaviour.

The combined forces of social media and rise of populism have amplified the politicization of knowledge. What is considered true often depends on group membership rather than scientific evidence and facts^{1–6}. This politicization is seen in numerous topics, including climate change. Overwhelming scientific evidence suggests that climate change is occurring⁷, is caused by human activity⁸ and is likely to result in dire consequences^{9,10}. Nonetheless, actions of governments around the world lag behind what climate scientists say is needed. In some cases, this inaction is related to a lack of concern about climate change. For example, in the United States, surveys show that over a third of the population believes that the seriousness of global warming is exaggerated¹¹, and more than half the population disagrees with the claim that climate change is caused by humans¹².

Raising concern about climate change and support for remedial action at the individual and collective level is challenging for numerous reasons. First, it is difficult to attribute a specific climate-related incident to a single cause. Second, remedial actions taken by one individual or collective often do not yield visible outcomes. Third, the cost of action is immediate whereas the benefits are distributed over long time horizons¹³. Specifically, while climate change will adversely impact future generations, for most people there is no immediate cost to rejecting its occurrence on ideological grounds¹⁴. Compounded by the brain’s challenges in thinking about temporally or spatially distant

events^{15–17}, these factors make it difficult to change sceptics’ views on the topic and garner support for corrective action.

However, acknowledging the role of erroneous beliefs that have no immediate cost offers a potential pathway to shifting people’s climate change-related attitudes and behaviours: devise a mechanism to make maintaining false beliefs costly in the near term. Research shows that people often behave in ways that contradict their stated beliefs when money is on the line¹⁸. For example, climate sceptics publicly deny global warming but do not invest in geographic regions that will probably suffer from a rise in sea levels¹⁹. Building on this, we suggest using climate prediction markets to shift attitudes towards the scientific consensus by increasing the cost of maintaining false beliefs. Simply, we provide a financial reward (/penalty) for correct (/incorrect) predictions about soon-to-occur events that are impacted by global warming using a prediction market.

Traditionally, prediction markets have been implemented to crowd-source estimates about uncertain events in the future²⁰. Those markets have been shown to accurately predict the outcomes of elections²¹, reproducibility of scientific findings²², spread of disease²³ or aggregation of group choices²⁴. In the context of climate change, prediction markets have been suggested as a tool for aggregating views on policies²⁵ and as a way to provide credible signals about climate science^{26–28}. However, there is no empirical evidence supporting the

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notion that betting on climate-related events can shift people's: (1) concerns about the consequences of climate change, (2) support for remedial action at the individual/collective level and (3) knowledge about climate topics.

Climate prediction markets

We introduce climate prediction markets as a novel intervention and report experimental findings on how participating in the markets influences people's concern about climate change, support for action and climate knowledge. Our market offers individuals the opportunity to bet on future outcomes (that is, 'the average temperature in the Northern Hemisphere in the coming month will be higher than that in the equivalent time window over the last decade') and earn money if their predictions are proven right.

We implemented two different prediction markets across two field studies. In both studies participants engaged in a market where they took positions on future climate events and earned money based on their prediction accuracy.

Betting topics were set by the experimenters and were released intermittently (between 1 and 3 days apart in Study 1 and daily in Study 2). The bets reflected both events that dominated the news (that is, California wildfires, extreme heat waves) and events that were less salient to the average participant (that is, Antarctic Sea ice extent, change in the Air Quality Index). All bets had a settle date/time and an unambiguous source for determining the outcome. We term a particular prediction a 'bet'. For each bet, participants could decide whether they wanted to make a bet, which position to take (Yes/No) and how much money to wager.

We surveyed participants before ('pre-survey') and after ('post-survey') the period during which they engaged in the prediction market (Fig. 1a). In both studies, we compared participants who engage in the climate prediction market to a control condition (Study 1: passive control group, Study 2: active control group that participated in a sports and entertainment prediction market). Comparisons with the control group allow us to account for changes that might occur naturally over time (for example, natural variation in the salience of climate disasters that are known to impact people's attitudes about climate change²⁹).

Study 1

Participants ($n = 143$) were recruited online and screened for climate beliefs and US nationality. Climate belief was defined as agreement with the statement 'Global warming refers to the idea that the world's average temperature has been increasing over the past 150 years and may be increasing more. Do you think that global warming is happening?' (Supplementary Table 5 and Supplementary Fig. 4 provide demographic and climate concern breakdowns for the 70 climate believers and 73 sceptics included in the study). We screened for individuals with polarized positions by selecting only individuals who answered 'Yes'/'No', skipping those who said 'Don't know'. Participants completed two surveys, one before the beginning of the prediction period and one at its conclusion. The surveys captured participants' concerns about climate change, support for climate action, climate knowledge and variables such as demographics, political orientation and more (Methods and Supplementary Information). Participants within the groups of believers and sceptics were randomly assigned to either the control ($n = 73$) or treatment group ($n = 70$). Each participant in the treatment group received US\$20 to fund bets in the prediction market. During the prediction period, participants made bets on future events (Supplementary Methods show all bets). Because of the double-auction structure of the market (if one participant bet US\$0.55 that an event would occur, it only becomes a contract if another participant bets US\$0.45 that the event will not occur; Supplementary Methods provide details on the betting mechanism), not all bets turned into contracts. We analysed bet offers as reflections of participants' willingness to

take a position on topics. Study 1 had 4,737 interactions (stock offers, trades and so on) with an average of 9.5 contracts per day.

Concern about global warming increases, conditional on winning

We first tested whether engaging in the climate prediction market had an impact on how concerned participants were about climate change. Specifically, we ran linear regressions to predict climate concern in the post-survey from experimental condition (0 = control, 1 = treatment), controlling for participants' concern in the pre-survey. Contrary to our expectations, participating in the climate prediction market did not lead to an overall increase in climate concern compared to the control group ($B = -0.005$, $SE(B) = 0.015$, $\beta = -0.001$, $t = -0.04$, $p = .976$; Fig. 2; all results hold when using the difference between pre- and post-survey as outcome). B , Unstandardized regression coefficient. SE , Standard error. β , Standardized regression coefficient. t , statistical coefficients of test; p , statistical coefficient of significance.

However, exploratory analyses of the treatment condition revealed an effect conditional on participants' performance in the betting market. Specifically, we used the robust MM-type estimator³⁰ to regress the difference in concern between post- and pre-surveys (higher values indicate a shift towards more concern about climate change) onto two indicators of performance: (1) the number of bets won and (2) total earnings. Here betting outcomes significantly and consistently predicted the change in concern (number of bets won: $B = 0.007$, $SE(B) = 0.003$, $t = 2.44$, $p = 0.017$; total earnings: $B = 0.01$, $SE(B) = 0.005$, $t = 2.37$, $p = 0.021$). That is, participants' concerns about climate change increased if they were accurate in their predictions.

Finally, we tested whether the impact of the treatment varied between believers and sceptics. Using the robust MM-type estimator to regress the difference in concern between post- and pre-surveys on the binary believer/sceptic variable, we saw a marginally significant effect ($B = 0.14$, $SE(B) = 0.08$, $t = 1.71$, $p = 0.089$) suggesting that the treatment was more effective for believers than sceptics. The moderating effects of performance on concern were found to be equally strong for both believers and sceptics ($B = 0.001$, $SE(B) = 0.01$, $t = 0.11$, $p = 0.911$).

To further explore participants' engagement with the climate prediction market, we tested for differences between believers and sceptics in betting outcomes (bets won and total earnings; Supplementary Fig. 2) and behaviour (confidence, defined as the distance from the neutral US\$0.50/US\$0.50 value). Despite believers being among the highest earners in our market (top 11% of earners), both groups did not significantly differ in the number of bets won ($B = 0.70$, $SE(B) = 2.01$, $p = 0.728$) or the total earnings ($B = 1.44$, $SE(B) = 1.33$, $p = 0.282$). However, the bets of believers indicated marginally higher levels of confidence ($B = 0.48$, $SE(B) = 0.24$, $p = 0.053$; Supplementary Fig. 6).

Altogether, Study 1 offers suggestive evidence that prediction markets can increase concern for climate change under certain conditions (that is, successful betting). Despite the promising results, Study 1 also suffers from a number of limitations. First, by virtue of its reliance on a real-world market resembling the one seen in public exchanges ('two-sided'), it was hard to isolate the treatment effects (that is, participants may have placed bets that did not turn into contracts). Second, the decision to target only individuals with polarized positions made obtaining a shift in concern challenging because believers are already at a climate concern ceiling, while sceptics are hardest to shift. Third, the size of our participant pool made it impossible to detect small effects that are common in behaviour-change research. Fourth, the fact that we opted for a passive control group that did not engage in any meaningful task during the prediction period prevented us from testing whether the effect of successful betting on concern was uniquely related to climate predictions or the result of participants experiencing positive outcomes.

Study 2 overcomes these limitations by testing the effects in a controlled experimental setting, with an active control group that

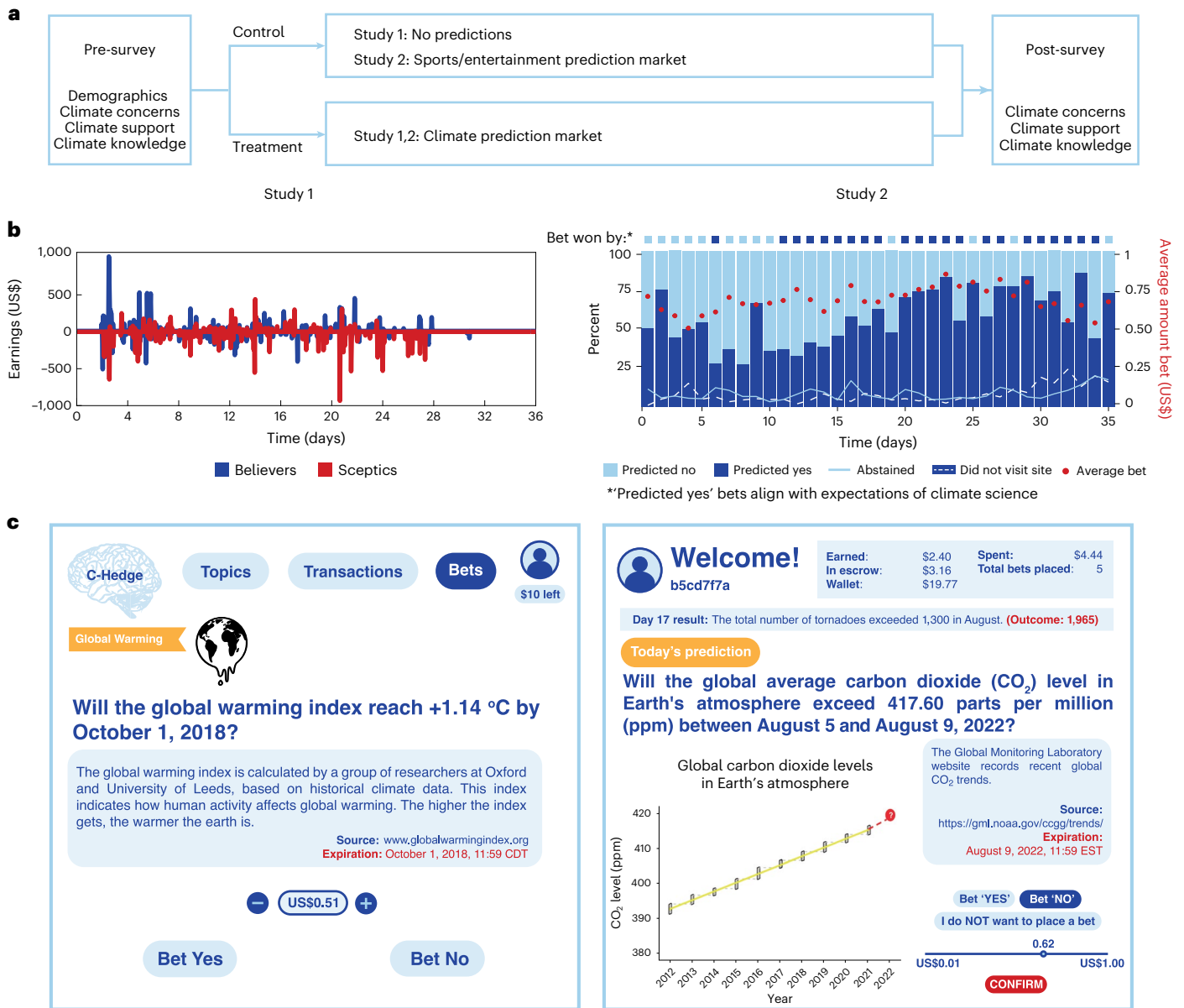


Fig. 1 | Experimental design. **a**, Participants first answered various questions about their views on climate issues in a pre-survey (Supplementary Tables 2, 4, 18 and 19 provide survey questions). Afterwards, participants were divided into treatment (climate prediction market) and control (Study 1: no predictions, Study 2: sports/entertainment prediction market) groups. **b**, Participants in the prediction markets made bets continuously (left: Study 1 earnings breakdown over time) or daily (right: Study 2; left y axis corresponds to the percent of participants taking yes/no/abstain positions on each daily bet, and the right y axis corresponds to the average daily bet wager). We denote above each bet

the prediction that ended up being accurate (note that we attempted to ensure that 'Yes' bets would align with climate science). **c**, Visualization of the climate predictions market in Study 1 (on a dedicated website, titled C-Hedge; left) and 2 (right). The wager in Study 1 ranged from US\$0.50 to US\$0.99 with a position of less than US\$0.50 amounting to switching (that is, US\$0.40 'Yes' is US\$0.60 'No'). The wager in Study 2 ranged from US\$0.01–US\$1. Following the prediction period, both treatment and control participants completed a post-survey addressing climate issues and assessments of their overall experience.

engaged in a non-climate prediction market, using a much larger sample size of people who are less extreme in their beliefs about climate change.

Study 2

Participants ($n = 1,005$) were recruited online similar to Study 1. Of the total participants, those ($n = 664$) who wagered at least US\$10 and placed at least 15 bets were included in the analyses. As in Study 1, pre- and post-surveys measured participants' climate concern, support and knowledge (Methods). Between surveys, participants were randomly assigned to either a climate prediction market ($n = 356$, treatment) or a

sports and entertainment prediction market ($n = 308$, control; Methods and Supplementary Information provide evidence that the randomization was successful). Both prediction markets ran for a period of 35 days during which one new bet was posted daily. Upon logging into the prediction market, participants saw an overview of their betting profile (amount won thus far, number of bets placed) and were informed about the outcomes of previous bets. Participants then saw the daily bet (Fig. 1c). Participants were asked to decide whether to bet, which position to take and how much money to wager. Each participant received US\$20 at the beginning of the study. Overall, participants placed 10,384 bets (15.6 bets per person).

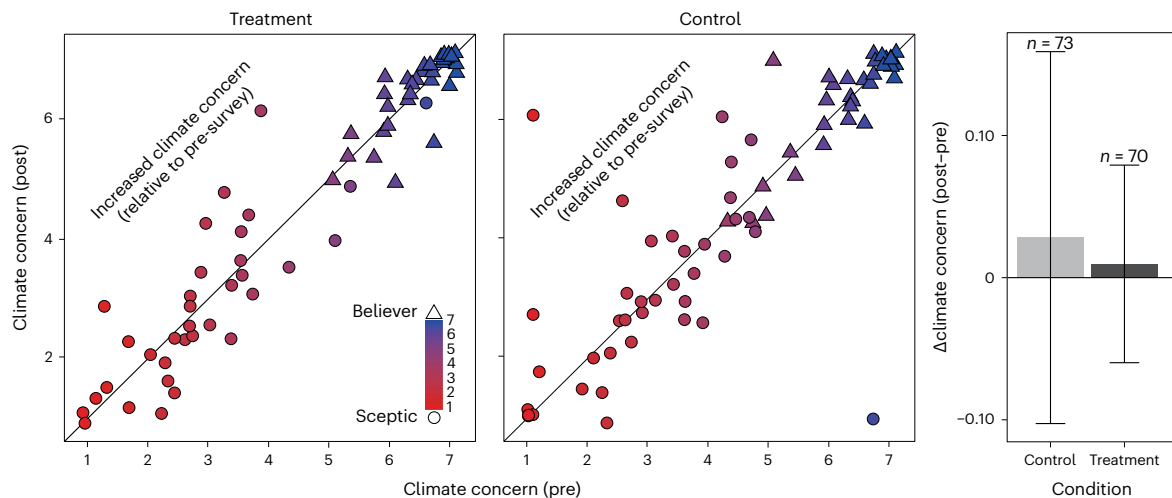


Fig. 2 | Distributions of climate beliefs before and after participating in the climate market. Taking the average of the three climate concern questions (Supplementary Fig. 4), we see that among the treatment ($t(68) = 0.14, p = 0.890$, two-tailed paired t test; left) and control ($t(70) = 0.22, p = 0.830$, two-tailed paired t test; centre) groups, there is no significant change in concerns following a month of waiting/betting (markers above the diagonal). Self-described believers

and sceptics are marked by different symbols. Participants' group designation aligns with the reported answer to the survey questions with the majority of believers scattered at the top-right of the panels (Supplementary Fig. 5). Right panel depicts the average difference concern score among treatment and control conditions between the pre- and post-surveys. Error bars depict standard errors ($t(106) = 0.12, p = 0.901$, two-tailed independent t test).

Increase in concern about global warming

We tested whether engaging in the climate prediction market had an impact on how concerned participants were about climate change, how supportive they were of remedial action and how much they knew about climate change. Specifically, we ran a series of linear regressions to predict climate concern, support and knowledge in the post-survey from category of experimental condition (0 = control, 1 = treatment) controlling for the respective concern, support and knowledge in the pre-survey and including the socio-demographic variables to increase the precision of the estimates (Supplementary Information 'Robustness checks'). The treatment group showed significantly higher levels of concern ($B = 0.12, SE(B) = 0.045, \beta = 0.08, t = 2.69, p = 0.007$; Fig. 3a), support for remedial action ($B = 0.13, SE(B) = 0.058, \beta = 0.09, t = 2.19, p = 0.029$; Fig. 3b), and knowledge ($B = 1.58, SE(B) = 0.22, \beta = 0.52, t = 7.15, p < 0.001$; Fig. 4) in the post-survey compared to the control group.

Given that we asked the same question regarding concern and support in the pre- and post-survey, we could compare participants' scores to understand the underlying mechanisms of the effects. Participants in the treatment condition showed significantly higher levels of concern in the post-survey than the pre-survey ($t(355) = 2.23, p = 0.026$; Fig. 3) while controls did not ($t(307) = -0.93, p = 0.353$; paired t tests). Similarly, participants in the treatment condition increased their support for remedial action ($t(355) = 2.89, p = 0.004$) while controls did not ($t(307) = 0.37, p = 0.712$; paired t tests).

In addition to testing our main hypotheses, we conducted a series of exploratory analyses. First, we tested whether the treatment effect was stronger in certain conditions (that is, as in Study 1, when participants were successful in their bets). While we did not observe significant interaction effects between the experimental condition and the bet winnings for climate concern ($B = 0.009, SE(B) = 0.011, \beta = 0.04, t = 0.75, p = 0.455$) or support ($B = 0.007, SE(B) = 0.014, \beta = 0.04, t = 0.55, p = 0.583$), we found a significant moderation for climate knowledge ($B = 0.182, SE(B) = 0.053, \beta = 0.41, t = 3.44, p < 0.001$). Notably, we observed a significant interaction between the treatment and political ideology. The treatment was more effective at increasing support for remedial action among more conservative participants ($B = 0.077, SE(B) = 0.036, \beta = 0.13, t = 2.14, p = 0.033$). All treatment effects were independent of initial climate concerns, suggesting that participants

at all levels of climate concern were equally affected by their involvement in the climate prediction market.

In line with findings on motivated reasoning^{1,6,31}, we observed a marginally significant relationship between political ideology and the percentage of bets that superficially align with climate change ($r = -0.10, t = -1.90, p = 0.058$). Testing for correlations between political ideology and outcomes (number of bets won, $r = -0.02, p = 0.526$; and total amount earned, $r = -0.004, p = 0.921$) or betting behaviours (total bets placed, $r = -0.01, p = 0.828$; and total amount spent, $r = 0.05, p = 0.192$) did not show any significant correlations (Supplementary Fig. 8). Accordingly, political ideology did not influence participants' engagement with the markets, confidence in their bets or prediction accuracy.

Implications of climate prediction markets

In line with existing theoretical arguments about the power of climate prediction markets³², our findings from two field studies suggest that participating in such markets can influence people's attitudes towards climate change. Specifically, we show that participants who bet on climate-related events reported higher levels of concern about climate change, showed higher levels of support for remedial climate action and had higher levels of knowledge on climate issues. While the positive impact of our intervention on attitudes was conditional on betting success in Study 1, it was unrelated to earnings in Study 2. This discrepancy might, in part, be explained by the fact that the participants in Study 1 were recruited to be highly polarized in their views on climate change.

The effects of our intervention are small, with our experimental condition explaining between 1% and 7% of the variance in the post-survey responses regarding concern, support and knowledge. However, we argue that our intervention offers a meaningful tool for behaviour change. Prior work has suggested that when considered at scale, small effects can turn into highly impactful outcomes³³. Further, our intervention results in positive attitude shifts across the entire political spectrum. Neither political ideology nor people's prior views on climate change moderated the effect. The only exception to this lack of moderation by political ideology was the shift in climate support in Study 2, where the intervention was stronger among more conservative participants. The success of the intervention is promising given that prior works have reported adverse reactive behaviour among climate sceptics targeted with attempts to shift their climate views^{12,34–37}.

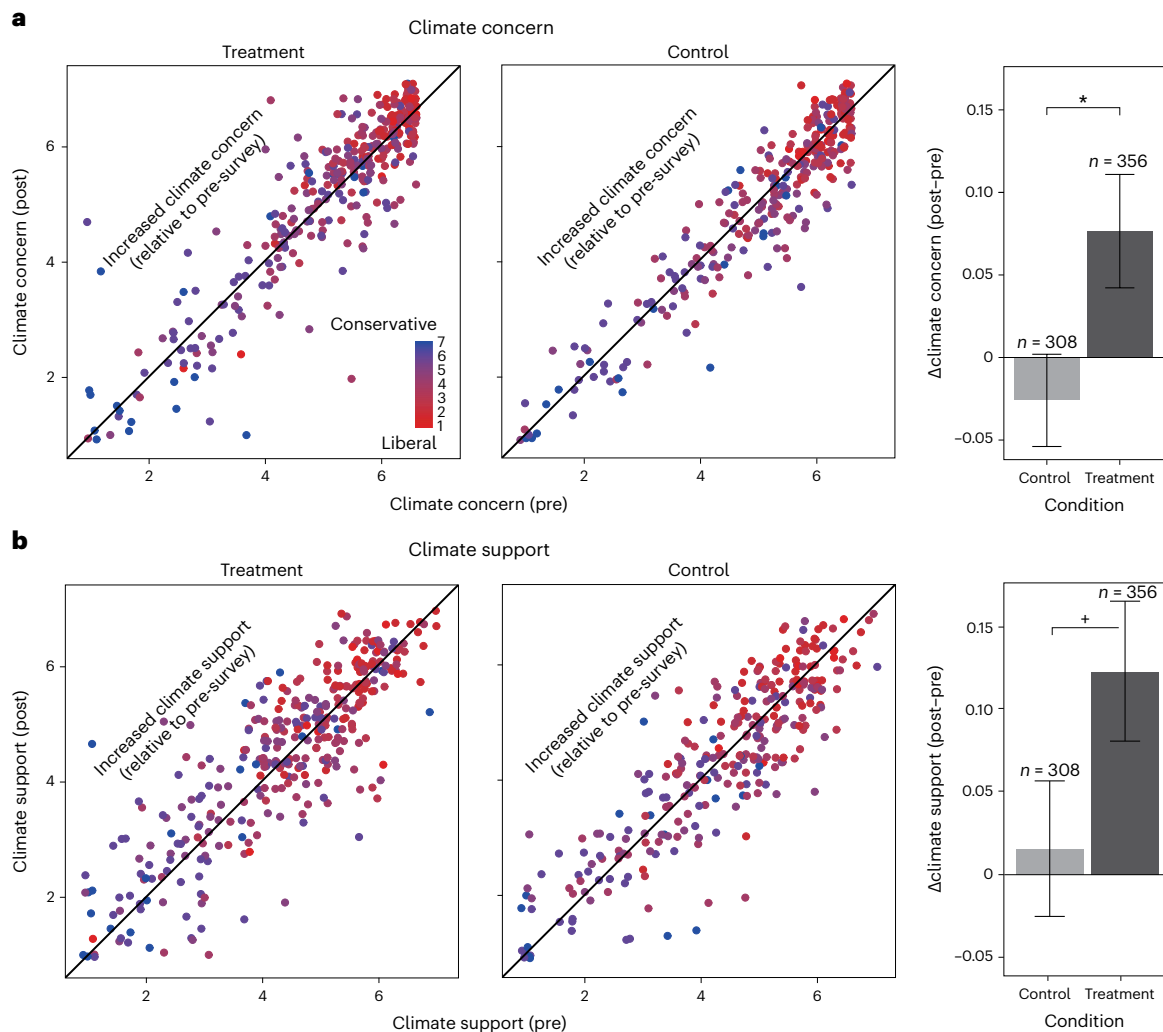


Fig. 3 | Effects of condition on climate concern and support. **a, b**, Participants concern (a) and support (b) before (x axis) and after (y axis) the prediction market. Right column depicts the shifts in concern across control and treatment conditions, calculated as the average difference scores across conditions

between the post- and pre-surveys. Error bars depict standard errors (Δ Concern: (651) = 2.27, $p = 0.024$, two-sided independent t test, Δ Support: $t(661) = 1.82$, $p = 0.069$, two-sided independent t test).

We propose that even if the participation in a climate prediction market is limited, the media accounts about market valuations, the prediction outcomes and the dissemination of knowledge that is derived from the markets may yield an increased shift in concerns in the larger population.

While it is difficult to translate the effects in field studies to population-level outcomes, there are some metrics that could be impacted by interventions such as ours. For example, if the prediction market in Study 1 was scaled to 1,000,000 climate believers and sceptics, and all believers decided to invest their annual earnings from, say, US\$500 in market money (US\$25, on average, if applied to our results) into countering climate change, this would result in an estimated US\$25,000,000 of additional funding for climate solutions. Note that this amount could quickly increase when considering highly motivated players that might have far greater yields than the 5% earnings observed for the average believer in Study 1. Similarly, given that participation in climate markets such as the one in Study 2 yields an increase in climate concern, support and knowledge, such an intervention among a representative subset of the population could yield a shift in attitudes among millions¹² of individuals (Box 1 provides implementation details).

The majority of previous attempts at getting people to update their existing position on climate change focused on highlighting scientific consensus^{37–41}, neutralizing partisan conflicts^{34–37} or appealing to norms^{31,42–45}. The success of a number of those efforts was driven primarily by increasing knowledge and providing information, which, in turn, helped shift perspectives. Some of the challenges in previous studies have been attributed to: (1) motivated reasoning (that is, rejection of new information that contradicts standing beliefs⁶), (2) desire to signal social identity within a group by clinging to information that fosters collective homogeneity⁴⁶, (3) active efforts to foster uncertainty about climate science⁴⁷. Our intervention offers a solution to all three of these challenges by: (1) making motivated reasoning costly, (2) anonymizing people's decisions (thereby protecting their position within a group of climate sceptics, for example) while conveying aggregated public opinion and (3) creating higher levels of certainty by having people actively engage with scientific sources. Additionally, because the change in attitudes is intrinsically driven, it has the potential to be less threatening to one's identity and hence more sustainable. Together, these features might allow people to engage with climate-related topics in a way that is less polarizing and less prone to partisan interpretation^{4,34–37}.

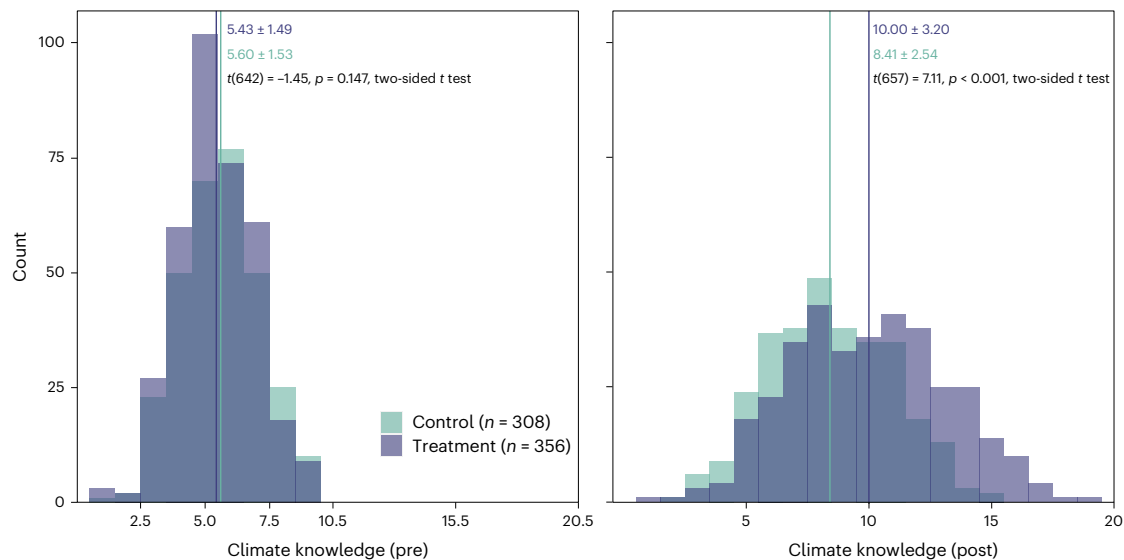


Fig. 4 | Climate knowledge increases after participating in a climate prediction market. Participants' knowledge was evaluated by comparing the treatment and control groups' knowledge in the pre-survey (left; n.s.) and

post-survey (right). Vertical lines are the mean of the corresponding color distribution. n.s., not significant.

Our findings contribute to the existing knowledge on behaviour change, both inside and outside of the climate domain. First, they align with existing empirical results on how betting can serve as a tool for boosting engagement and behaviour change. For example, participating in sports prediction markets was shown to drive engagement with athletics⁴⁸, and trading stocks of companies increases people's consumption of news related to those companies⁴⁹. Second, the findings speak to a growing body of work suggesting that reducing the 'distance' (psychologically, temporally or spatially) to a problem can lead to shifts in attitudes and behaviours^{37,50,51}. For example, people who live closer to coastlines, where the effect of climate change is more concrete, express greater concern about climate change and higher support for regulating carbon emissions⁵², although unlike our intervention, this may not hold for sceptics⁵³. While our intervention does not change the physical setting of participants, continuous engagement with tangible climate-related events may reduce the psychological distance to climate change and make its impact appear more imminent. Third, our findings align with simulations suggesting that participation in climate prediction markets should foster alignment with scientific climate consensus³².

Limitations

Our studies had a number of limitations. First, given that these were field experiments involving real-time responses, the results are impacted by ongoing events (that is, actions taken by other participants, news cycle or saliency of climate-related events). In Study 2, for example, climate events dominated the news during our pre-survey period (including a 50-year record high heatwave in Europe), which probably has impacted our baseline climate concern and support levels. This might have made it harder to see bigger increases in concern in the post-survey. By virtue of their realistic nature, our studies produce findings of high ecological validity and the results might vary depending on when the studies are conducted. Future climate prediction market studies should replicate our findings across multiple time windows to corroborate the outcomes' generalizability.

Second, given that the participants were recruited based on location and climate beliefs, our results reflect the behaviour of US participants and not necessarily the world population. Indeed, the polarization of US citizens with respect to climate change is larger

than in other countries⁵⁴. This polarization might have made it more difficult to shift concerns with our prediction markets, suggesting that our results could be a conservative estimate of the effect size elsewhere.

Third, we cannot speak to the exact mechanisms of our effects. Betting behaviour is the reflection of a complex combination of factors, including: (1) participants' view/knowledge on topics, (2) their confidence, (3) their risk tolerance, (4) their understanding of the market forces, (5) the amount of time participants have to do research and place bets, (6) the availability of funds, (7) the likelihood that others would take the opposite position of a prediction (in Study 1) and (8) the available information on the outcomes (that is, more data were available as the settle dates approached, in Study 1) and other psychological mechanisms. Future research could investigate these mechanisms individually.

Fourth, our limited study duration imposed a stringent cap on the temporal horizon of predictions. This cap aligns poorly with the longer timescale of climate change. We could not, for example, look into notable changes in Earth's temperature within the time limit. This limitation forced us to generate climate predictions with large spatial domains (that is, multiple cities) or comparison to historical events. The uncertain relationship between near-term events and outcomes causally related to global warming inevitably caused some of our markets to reflect weather events rather than climate events. An implementation of climate prediction markets on a longer period (that is, years) would allow for long-term predictions and understanding of the effect of new information on these predictions, irrespective of the temporal horizon (that is, predictions about the year 2100 can be updated far ahead of their settle date if new information in, for example, 2025 suggests a need for change of bet values). In fact, when Study 2 concluded, we asked participants to make predictions that span years into the future (Supplementary Table 19), which could be analysed when they settle (data available along with our Supplementary Information).

Fifth, our studies were limited to a financial allotment of US\$20 per participant, capping motivation and outcomes. Participants were limited to using their allotted amount and, correspondingly, participants who lost much of their income early were effectively excluded from further activity (and presumably less engaged with the study). The fact that participants did not invest their own money may have changed their overall motivation compared to prediction markets in

BOX 1

Applications

Climate prediction markets can be a useful tool for financial policy estimation²⁷, for evaluation of public opinion²⁵ and for aggregation of views and signals about the future^{26–28}. Importantly, by making false beliefs regarding the future impacts of climate change costly, climate prediction markets are likely to present a more accurate reflection of expectations about climate change. As such, they might help overcome politically motivated scepticism and gradually shift attitudes by highlighting that concern about climate change is more widespread than surveys suggest. Our finding that in various conditions the shift in concern was stronger among conservatives is particularly notable in this regard. As one key attribute of any prediction market is its reliance on an independent adjudicator, the power of prediction markets is that participants, upon entry, agree on the source they will use to determine the outcome.

An additional advantage of climate prediction markets is that they make it possible to quantify probabilities about future events long before the outcomes are manifested. In Study 1, for example, participants traded positions with different values far before the contracts' settle date. This indicates that the additional information about the future manifested itself in people's present behaviour regardless of the ultimate outcome. As an example, outcomes of electoral bets (say, the winner of a presidential election in Brazil) may not be determined for several months. However, new information about current events and policies might change the bet's value in ways that capture the crowd's changing estimate of the probability of the outcome.

Taken together, these prediction markets' properties make their application at scale (that is, under a federally regulated authority) a promising instrument in the arsenal of climate policymakers⁵⁶. As current direct financial incentives—for example, tax credits or government subsidies—produce limited results with respect to shifting concerns on climate⁵⁸, prediction markets could act as a complementary tool for climate policy. The introduction of large-scale prediction markets for climate change could create a new

sector of the financial information industry where climate attribution and prediction modelling would grow from a small academic enterprise to one that can help numerous governmental and private sector entities plan for the manifold effects of climate change and prioritize mitigation efforts.

Implementing multiple climate prediction markets over the course of this work has highlighted the importance of market makers (that is, the individuals generating the bets) in the process. For example, the selection of market topics or market launch times may influence market activity by nudging participants towards engagement with a specific topic. Similarly, setting markets that are realistic and fair requires effort and knowledge on the topic. Bets that are too extreme in any direction make all participants act in unison irrespective of their personal opinions. For example, the thresholds we chose for settling the first set of markets in Study 2 led to almost all bets resolving in favour of predictions that aligned with climate scepticism (Fig. 1b). Although we do not find evidence that this alignment with climate scepticism affected our main outcomes (shift in climate concern and support), it resulted in a general shift among participants towards more conservative bets in subsequent markets (Supplementary Information 'Mid-study survey' examines this effect). The impact that such choice of markets can have on the outcomes (and associated attitude change) raises concerns about potential market manipulation. While prior work has explicitly suggested market manipulation as a means to subsidize certain positions, encourage informed traders and reward accuracy²⁵, our experience suggests that this is not necessary for shifting attitudes. Put simply, engaging in climate prediction markets without any manipulation yields increase in concern about climate change and support for climate action. The unfortunate reality of climate change means that any randomly chosen period of time we may have selected for our studies would have had an abundance of salient climate anomalies that yielded an increase in concern about climate change. Given trends in global warming and its causal role in extreme weather events, this will be even more true in the future.

public exchanges. However, prior work has suggested that using virtual money may be as effective as real money⁵⁵. We argue that this limitation may indicate that a real-world prediction market could in fact amplify the outcomes identified.

Taken together, these limitations suggest that while our work provides an initial feasibility test for climate prediction markets, further research should examine the markets' ability to shift attitudes persistently across a more diverse set of samples. Specifically, future work should investigate whether changes in concern, support and knowledge are sustained long term and whether continuous participation in climate markets solidifies those changes. Additionally, further analyses of the bets could focus on the positions taken by individuals as dependent observations to test whether certain outcomes affect future attitudes or bets (that is, losing multiple bets in sequence leading to less extreme bets).

Finally, we strongly advocate for replication of our results using large-scale prediction markets, implemented over a longer period in an open, non-experimental setting⁵⁶. This would allow market forces to strengthen the effects and could lead to widespread attitude change.

Conclusion

This study offers empirical evidence for the ability of prediction markets to change people's attitudes about climate change. The engagement

with climate prediction markets in a domain that is uniformly quantitative and less polarizing than politics could not only support existing methods to change climate concerns^{4,13,51,57} but also act as an ultimate polling tool to help scientists, activists and politicians aggregate public opinion about trends, policy preferences and future scientific predictions. It has not escaped our notice that the powerful financial instrument proposed here could be used in other topics of controversy where an agreed-upon arbiter of truth could allow individuals to reflect their views through market economics rather than publicly stated opinions.

Online content

Any methods, additional references, Nature Portfolio reporting summaries, source data, extended data, supplementary information, acknowledgements, peer review information; details of author contributions and competing interests; and statements of data and code availability are available at <https://doi.org/10.1038/s41558-023-01679-4>.

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Methods

Study 1

Participants. A total of 160 participants were recruited for the study. Participants were recruited online using Prolific Academic and through the Reddit 'Climate Change sceptics' group. Participants were screened on Prolific using two questions: (1) 'What is your nationality?' (only participants who answered 'United States' to this question were eligible to participate) and (2) 'Do you believe in climate change?' (people could answer: 'Yes', 'No', 'Don't know' or 'Not applicable/rather not say'; an equal number of people saying 'Yes' or 'No' were recruited). Participants' location within the United States varied and spanned areas that are deemed high and low for their support for climate change science⁵⁹ (Supplementary Fig. 1). To ensure that participants' beliefs about climate change were consistent with the earlier Prolific screening, we added an additional filter question ('Global warming refers to the idea that the world's average temperature has been increasing over the past 150 years and may be increasing more. Do you think that global warming is happening?'; Answers: 'Yes', 'No' and 'Don't know'). Only people who responded 'Yes' or 'No' were included in the study.

Seventeen participants were excluded from the analysis, broken down as follows: three were excluded because they did not complete the required surveys, five because they failed an attention check question in either the pre-/post-survey and nine because they did not fulfil the requirement to use the entirety of the allotted US\$20. Of the 143 remaining participants, 73 were used as controls (35 believers, 38 sceptics) and the remaining 70 were used as the treatment group (35 believers, 35 sceptics). Supplementary Table 5 provides a breakdown of all participants' demographics.

Participants in the control group received US\$5 for completing the pre-survey and an additional US\$5 for completing the post-survey. Participants in the treatment group received the same remuneration for these surveys, along with additional US\$20 to spend in the climate prediction market (Supplementary Fig. 3 provides bet topics distribution). Participants were instructed to use the full amount for climate predictions. At the end of the study, participants received their earnings in the climate prediction market. Participants who lost all their US\$20 allotment during the betting period received only a US\$10 participation fee. In total, participants in the treatment group could earn anything from US\$10 (participation fee) to a maximum of US\$650 (participation fee and their earning from bet wins).

Experimental procedure. On the day of the study initiation, participants received a message instructing them to complete a pre-survey. At the end of the survey, they were given a personalized link to a web-based online climate betting site. Upon logging in to the site, they were presented with a number of climate betting markets and could take a position on any number of them (Fig. 1). In addition, participants could choose to trade a position with other participants. The number of available markets changed daily based on old markets closing and new markets opening. Participants could place multiple bets on the same market and could trade continuously before the bet's settle date and time.

During the betting period, participants could log in to the prediction market site whenever they wished, monitor their currently available funds, view the available markets, make bets or trade positions. The market mechanism was 'double auction' (Supplementary Information), which required two participants to take opposite bets such that the sum of two bets was US\$1 (that is, if one participant chose to wager US\$0.60 that a 'Yes' bet will occur, only when another participant wagered US\$0.40 that a 'No' on the outcome would a contract be initiated). If no participant was willing to take the opposite wager, the offer remained pending until the participant making the offer chose to revoke it. The manifested value of each market at any given moment was that of the last 'Yes' transaction to occur. That is, if a participant made a bet for US\$0.82 that the average methane level in October 2018 will be the highest on record and another participant took the opposite

position at US\$0.12, then all participants saw the current market value as US\$0.82. Accordingly, the values of markets represented the aggregated stable amount of money people were agreeing to wager on each topic. Naturally, as the settlement date of markets approached, the bets were likely to converge to the probability (0...100) of the correct outcome (that is, if the market asked whether the number of disasters in a certain location be more than 10 by a certain date, and a few days before the closing time, a number of disasters already reached 9, the likelihood of a 'Yes' bet was higher). The betting period was initiated on 9 September 9 2018, and lasted until 11 November 11 2018. When the betting period was complete, participants were instructed to complete a post-survey. Once participants completed the post-survey, they were paid for their participation in the entire study. The pre- and post-surveys included a variety of questions (Supplementary Information provide all questions), but the main focus of the study was the subset of questions pertaining to the concern about climate change.

To ensure the site's robustness to large-scale use and to reduce the risk of technical issues jeopardizing the real-time experiment, we ran a pilot test of the site for two months before the experiment on a smaller group of participants.

Study 2 was similar to Study 1 in its design, with the following deviations: (1) the criteria for exclusion in Study 1 was stricter (that is, participants were asked to use the full amount of money allotted to them), (2) the betting period in Study 1 was longer and bets were not released daily but rather intermittently, (3) the participant population for Study 1 was selected such that the pool was more polarized, (4) the control group for Study 1 did not participate in an alternative prediction market, (5) the treatment group's bets in Study 1 occurred in a double auction, which pitted the believers and sceptics against each other with predictions occurring only when two participants claimed opposite sides of a bet such that the sum of the positions was US\$1 (Supplementary Information provides an explanation of the double-auction fulfilment method), (6) participants in Study 1 could trade their bets in the market as the settle date was approaching based on the value of the trade at the time, (7) participants in Study 1 did not have to take a position on a bet as soon as it appeared on the portal but could choose to make a decision to enter as more information became available (the option price presumably reflected the information availability and outcome certainty), (8) participants in Study 1 could take contrary positions on the same bet or hedge their bets with a variety of positions.

Study 2

Participants. Participants were recruited through an online panel, Prolific Academic. Our target sample for the start of the study was 1,000 participants with anticipated attrition rates of approximately 30–40% over the course of the entire assessment period. To obtain this initial sample, we recruited 1,754 participants whose native language was English and who currently resided within the United States. We used Prolific's representative sample criteria to ensure that the sample was generalisable. We excluded participants who took less than two minutes to complete the survey and who failed an attention check embedded in the survey ($n = 134$).

All participants were asked a series of questions about their concerns pertaining to climate change, their support for climate action and their knowledge on basic climate-related topics (Measures). We further excluded participants whose answers were at ceiling (by calculating the sum across four 'Concern' questions with a score of 1–7 each and excluding participants with a score of 27 or 28, out of 28; $n = 615$; Supplementary Information).

A total of 1,005 participants met all inclusion criteria. Participants were randomly assigned to a treatment ($n = 524$) or control condition ($n = 481$; Supplementary Table 6). Participants in the treatment condition were told that they would participate in a four-week-long climate prediction market, while participants in the control condition were told about their participation in a sports and entertainment prediction

market (Supplementary Table 6 provides evidence that the treatment and control groups randomization assignments did not significantly differ from one another).

Each participant was allotted US\$20 to use for bets throughout the study. We considered participants' study records complete if they: (1) placed at least 15 bets and spent at least US\$10 from their allocated wages during the prediction period, (2) completed the post-survey at the end of the study, which included the same climate-related measures (that is, concern, support and knowledge) as the pre-survey. After excluding participants who did not meet these criteria, we were left with an analysis sample consisting of 664 participants (34% overall attrition rate; 32% in the treatment group, 36% in the control; $\chi^2(2) = 1.71$, $p = 0.191$, n.s.). Participants were compensated with a fixed sum of US\$11 for completing the pre- and post-surveys and a variable additional amount depending on their earnings in the prediction period.

Experimental procedure. The study consisted of three main building blocks: (1) the pre-survey that measured participants' concern about climate change (climate concern), their support for possible solutions (climate support) and their knowledge on climate issues (climate knowledge) before the intervention, (2) a five-week-long prediction market and (3) a post-survey that captured climate concern, support and knowledge following the intervention. Participants were recruited between 17 July and 21 July 2022 and completed the pre-survey as part of the initial screening procedure. After exclusion, participants were randomly assigned to the five-week climate (treatment) or sports/entertainment (control) prediction markets. The betting period started on 1 August 2022 and concluded on 4 September 2022. The final bet was settled on 6 September 2022. The post-survey was sent to participants on 8 September 2022 and was closed on 14 September 2022, at which point all participants were paid (Fig. 1).

Each participant received a unique login identifier that allowed them to use a personalized version of study surveys. Every day at 10:00 all participants received an email through the study messaging system indicating that a new bet was available on the prediction portal. The message included a link to the prediction portal.

Upon receipt of the daily reminder, participants had 20 hours to enter the portal (Fig. 1), look at that day's bet and decide whether to make a prediction. Once participants logged in to the portal, they were greeted with their personal identification and a summary of their personal study metrics. The metrics were: how many bets they had already placed, how much money they currently held in their wallet, how much money they had in bets escrow (that is, bets awaiting resolution) and their total earnings up to that point. Below the metrics, participants saw a summary of the bets that already materialized and their outcome. Below this information, participants saw the day's new bet (that is, 'Will the number of wildfires in California exceed 5,500 by August 8, 2022?') alongside the bet's settle date/time (that is, 'August 8, 2022, 23:59 EDT'), the source for determining the outcome (that is, '<https://www.fire.ca.gov/incidents/2022>') and (where possible) a graph of the history of the variable being bet on, showing the settle date of the current bet with respect to that graph.

Participants were then asked to indicate whether they wanted to abstain from betting, predict 'Yes' or predict 'No'. If participants elected to make a Yes/No prediction, they advanced to the next screen where they were asked to select the bet amount. Depending on their level of confidence, participants could bet any amount between US\$0.01 and US\$1. After participants determined their position and bet wager, they were asked to confirm their decision or restart their decision. Once the participants confirmed their decision, the bet was locked for the day and they were not able to alter their bet.

Measures

Climate concern. We measured people's concern about climate change in both the Pre- and Post-survey using the following four items: 1) 'Do you think that global warming/climate change is happening?' (Definitely

not—Definitely yes, 2) 'Do you think global warming/climate change is the result of human activities?' (Definitely not—Definitely yes), 3) 'How much risk do you believe global warming/climate change poses to humanity's health, safety and prosperity?' (None at all—Extremely high), and 4) 'Some people say that global warming/climate change is simply a scam. What do you think about this?' (Strongly disagree—strongly agree; reverse coded). The measure was adopted from work by Weber and colleagues⁵⁴. Responses were recorded on a 7-point scale. With a Cronbach's alpha of 0.93 in both the Pre- and Post-surveys, the internal consistency of our measure was found to be excellent.

Support for climate change solutions. We measured people's support for climate change solutions in both the pre- and post-survey using the following three items: (1) 'Addressing global warming/climate change should be a priority of the government' (strongly disagree—strongly agree), (2) 'I feel personally responsible to help slow down global warming/climate change' (for example, by making changes to my lifestyle or paying higher taxes) (strongly disagree—strongly agree) and (3) 'Some people say that climate change is real, but that the cost of fixing it today might not be worth the investment (that is, that the cost of fixing it today is higher than the cost of the damages caused by it)' (strongly disagree—strongly agree). Responses were recorded on a seven-point scale. With a Cronbach's alpha of 0.84 in the pre- and 0.87 in the post-survey, the internal consistency of our measure was found to be good.

Climate knowledge. The questions for climate knowledge differed between pre- and post-survey. The pre-survey asked ten relatively generic multiple-choice questions (that is, 'How many major layers does Earth's atmosphere have?' Or 'What is the primary effect of greenhouse gasses?'). The post-survey, on the other hand, asked a more comprehensive set of questions that were directly related to knowledge about climate change (that is, 'When does a tropical disturbance become a tropical storm and gains a name?' or 'What percentage of heat from global warming has the ocean absorbed in the past 40 years?'; Supplementary Tables 2, 4, 18 and 19 provide all questions).

Socio-demographic control variables. We collected information about a wide range of participants' socio-demographic characteristics. These included: age, gender, ethnicity, education, employment status, income, religious beliefs, political ideology and number of children (Supplementary Tables 18 and 19).

Ethics statement

All participants in Study 1 and Study 2 signed an online consent form upon initial engagement with the pre-survey. Study 1 protocols were approved by Northwestern University's Institutional Review Board (STU00206273). Study 2 protocols were approved by Columbia University's Institutional Review Board (AAAU2501).

Reporting summary

Further information on research design is available in the Nature Portfolio Reporting Summary linked to this article.

Data availability

The data generated during the work are available at <https://doi.org/10.17605/OSF.IO/PH72Y>.

Code availability

The codes used for the analyses are available at <https://doi.org/10.17605/OSF.IO/PH72Y>.

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Author contributions

All authors equally designed the research, performed the research, analysed the data and wrote the paper.

Competing interests

The authors declare no competing interests.

Additional information

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Participating in a climate prediction market increases concern about global warming

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Supplementary Methods

Study 1

Explanation of double-auction prediction markets

Suppose a bet on the site states that “It is going to rain tomorrow”. If participant A takes a position predicting this will come true with a stake of 60¢, and another participant, B, takes the opposite position claiming that it will not rain with a stake of 40¢, then a contract is created. Once a contract is created participants can either wait for it to expire and receive \$1 if they were correct (the other party loses their investment) or sell the position for a higher/lower price to another participant.

Participants can buy more than one position on a bet or try to buy/sell existing contracts before they expire if they change their views based on new information, or if they wish to use their money on other bets.

Prediction markets combine futures predictions (i.e., sports betting) with variants of stocks exchange. The prediction market we developed acts in the following way:

- The market administrators (in our case, the experimenters) generates a new bet. A bet has a start time, an expiration time, a category (i.e., “climate”), a specific binary outcome (i.e., “The number of Tsunamis in Thailand in October 2018 will be larger than in October 2017, by the expiration date”) and a pre-determined source that will be used to verify the answer’s accuracy (i.e., “based on the data provided by NASA on their website www.nasa.gov/disasters at 23:59 PST on November 1 2018.”).
- Once a betting market is launched participants can make predictions on it. At any given time, several bets are available for participants to choose from. A participant who is interested in making a prediction must, first, identify the side they want to take (i.e., believe that the outcome will occur, or not). Following that decision, the participant translates their belief into a numeric estimate ranging from 50¢-99¢ (50¢ being the lowest likelihood that the event outcome will occur, and 99¢ being the highest likelihood). A position that is lower than 50¢ (i.e., 30¢) is equivalent to the matching position (100-30) of the opposite direction (as if instead of clicking “Bet Yes” the participant clicked “Bet No” or vice-versa). For example, if a participant wanted to “Bet Yes” for “tomorrow it will rain” with a value of 30¢, they would select “Bet No” and enter 70¢.
- The position claimed by a participant is manifested in an allocation of funds from the participant’s wallet towards the position. That is, if a participant has \$20 and they take a position on a bet with 65¢ then 65¢ will be withdrawn from their account and turned into a position call. Their funds will be placed in an escrow account while they are waiting to learn whether someone in the market is willing to take the complementary position to theirs. The participant's balance will then show \$19.35, and they will have an offer position of value of 65¢.
- As long as no other participant claims the counter position, the offer is pending. The participant can cancel their offer at any time before a contract is generated, and the funds return to the virtual wallet. Participants can have offers of different values on the same bet (i.e., a participant may have three positions for 55¢, 60¢, and 99¢ on the same bet).

- Once an offer is made it is visible to all participants on the site. Participants who wish to take the position opposite to an offer made can place a prediction so long as its monetary value totals 100¢ with an existing offer. Doing so creates a contract. For example, if participant A created an offer on “Bet No” for “it will rain on the following day” with a position of 60¢ (claiming that the outcome of the bet will not happen), then participant B can create a counter position on the same bet (claiming that the outcome will happen) with a reversed position of “Bet Yes” but with a value of 100¢-60¢ or 40¢. In that case, a contract is created and both sides now hold a “stock on the market”.
- Once the bet’s settle date and time arrives and the outcome is determined (say, it in fact did not rain on the following day as participant A had bet), then participant A receives 100¢ (“win”). Participant B receives nothing (“loss”).
- Participants can sell their position in a contract at any point if another participant is willing to buy their position. A participant who holds one side of a contract can put out an offer to sell the position for any price up to 99¢. The price can be lower than the amount they offered to enter the contract or higher. Presumably, the price is a reflection of the updated knowledge on the outcome’s likelihood. For example, if a market stated that “There will be 10 Hurricanes during the month of September”, and a participant claimed the position that this indeed will happen by buying “yes” for 60¢, they may choose to sell the stock for 90¢ later in the month if by then there had already been 9 Hurricanes and there were still two weeks left for the month (as the likelihood of the position winning has increased). Overall, selling positions that already are part of a contract can be done any time before the settle date and time of the specific market (“Expiration”). In order to complete a sell of a position, the participant holding the stock places an offer for a price. A different participant who wishes to purchase the stock chooses to buy it for the specific price and now holds the position instead of the first participant. This transaction allows participants to exchange stocks with others who hold the same “view” on a bet (that the corresponding event will happen, or will not happen) rather than create a new contract. Once such an exchange has happened the new participant owns the corresponding side of the contract and wins/loses the contract when the bet expires. The participant who sold their position is no longer involved with the contract.
- Offers that were placed but did not materialize into a contract (as no participant claimed the opposite side) are automatically cancelled when the market settle date and time arrives. The offered funds return to the participant's virtual wallet from escrow.
- If a participant is out of funds (i.e., they lost all their money or placed all their funds in contracts that have not yet been settled), then they cannot place additional bets.
- At any given time, the website shows the price of the last contract that was set as the bet's current stock price. If a contract on a bet was created with the positions 60¢/40¢ (60¢ that it will not rain tomorrow), then the website will show that the market’s “no” price is 60¢. This acts as a running estimate of the amount of money participants are willing to invest in the position depicted in the market. Presumably, as bets approach their settle date and time, the positions may get closer to 99¢/1¢ (since all participants have the maximal knowledge on the likelihood of the market outcome).

Betting website

The C-Hedge website front-end was coded using JavaScript with React. The back-end used Node.js with Express. The website ran on Amazon Web Services for high throughput and concurrent load balancing using Dynamo DB for data collection. Participants in the study created

an account on C-Hedge using a unique username and password. Surveys were anonymous and hosted by Qualtrics but required entry of the participant's *Prolific ID*. The C-Hedge bet transactions and survey data were linked by the *Prolific ID* so that participant identity was never available to the experimenters. All payment details and C-Hedge help requests were mediated by *Prolific Academic*.

The website implementation included database tables pertaining to user information (hashed password, account creation date, funds, etc.), bets information (expiration date, topic, title, validation source, etc.), and transaction information (action state, timestamp, betting user, money in cents, etc.). The experiment team provided an ad-hoc rapid technical support service throughout the betting period to assist participants and ensure that the markets are not halted in any way due to operational difficulties. All messaging occurred via *Prolific* to preserve the anonymity of the participants.

Climate markets

Market #1

Topic: Air quality

Bet: Will the AQI of the dominant pollutant in Shimizukōji, Miyagi-ken, Japan exceed 250 during October 1, 2018?

Source: <http://aqicn.org/city/japan/sendaihiwakabayashiku/gokyo/>

Expiration: October 1, 2018, 23:59 EDT

(Outcome: No)

Market #2

Topic: Air quality

Bet: Will the AQI of the dominant pollutant in Ocean View, Hawaii, exceed 50 but not 90 during October 14, 2018?

Source: <http://aqicn.org/city/usa/hawaii/ocean-view/>

Expiration: October 14, 2018, 23:59 EDT

(Outcome: Yes)

Market #3

Topic: Weather

Bet: Will there be more than 6 hours of rain on October 9, 2018 in Seattle, Washington?

Source: <http://www.accuweather.com/en/us/seattle-wa/98104/daily-weather-forecast/351409?day=5>

Expiration: October 9, 2018, 23:59 EDT

(Outcome: No)

Market #4

Topic: Weather

Bet: Will the temperature in Cairo, Egypt be above 100 degrees on October 29, 2018?

Source: <http://www.accuweather.com/en/eg/cairo/127164/weather-forecast/127164>

Expiration: October 29, 2018, 23:59 EDT

(Outcome: No)

Market #5

Topic: Weather

Bet: Will there be 3 or more thunderstorms during the week of October 24-30, 2018 in New Orleans, LA?

Source: <http://www.accuweather.com/en/us/new-orleans-la/70112/july-weather/348585>

Expiration: October 30, 2018, 23:59 EDT

(Outcome: Yes)

Market #6

Topic: Weather

Bet: Will there be more than 60% precipitation in Beijing, China on October 25, 2018?

Source: <http://www.accuweather.com/en/cn/beijing/101924/daily-weather-forecast/101924?day=4>

Expiration: October 25, 2018, 23:59 EDT

(Outcome: No)

Market #7

Topic: Global Warming

Bet: Will any coastal water temperature surrounding the U.S. rise above 90 degrees, but below 95 degrees on October 10, 2018?

Source: <https://www.nodc.noaa.gov/dsdt/cwtg/all.html>

Expiration: October 10, 2018, 23:59 EDT

(Outcome: No)

Market #8

Topic: Global Warming

Bet: Will the daily average temperature in the following cities: New York City (NY), Houston (TX), San Diego (CA), Oklahoma City (OK), Little Rock (AK), Frankfort (KY) by October 10, 2018 be above the average of the same cities in October 2017?

Source: <https://www.ncdc.noaa.gov>

Expiration: October 10, 2018, 23:59 EDT

(Outcome: No)

Market #9

Topic: Global Warming

Bet: Will NASA maintain 2018's global average temperature highest on record?

Source: <https://climate.nasa.gov/vital-signs/global-temperature>

Expiration: October 10, 2018, 23:59 EDT

(Outcome: Yes)

Market #10

Topic: Global Warming

Bet: Would the global warming index reach +1.14°C by October 1, 2018?

Source: <http://www.globalwarmingindex.org>

Expiration: October 1, 2018, 23:59 CDT

(Outcome: No)

Market #11

Topic: Politics

Bet: Will the word pair "Climate change" appear on the front page of the Fox News website in the coming 3 days?

Source: <http://www.foxnews.com>

Expiration: October 22, 2018, 23:59 CDT

(Outcome: Yes)

Market #12**Topic:** Politics**Bet:** Will any of the climate scientists involved with the recent Intergovernmental Panel on Climate Change (IPCC) which states that ‘Warming from anthropogenic emissions will continue to cause further long-term changes in the climate system’ challenge the results of the report in the next 2 days?”**Source:** <http://www.ipcc.ch?code=BRW&program=ccgg&type=ts>**Expiration:** October 15, 2018, 23:59 EDT**(Outcome: No)****Market #13****Topic:** CO₂ Levels**Bet:** Would the daily average Carbon Dioxide, CO₂ measured at Barrow, Alaska on October 15, 2018 exceed its value at this time last year?**Source:**<https://www.esrl.noaa.gov/gmd/dv/iadv/graph.php?code=BRW&program=ccgg&type=ts>**Expiration:** October 15, 2018, 23:59 EDT**(Outcome: Yes)****Market #14****Topic:** Disasters**Bet:** Will more than 5 U.S. states be in D4 drought (exceptional drought) condition on September 30, 2018?**Source:** <https://droughtmonitor.unl.edu/CurrentMap/StateDroughtMonitor.aspx>**Expiration:** September 30, 2018, 23:59 CDT**(Outcome: No)****Market #15****Topic:** Disasters**Bet:** Will there be more than 15 floods in the U.S. on October 1, 2018?**Source:** https://waterwatch.usgs.gov/new/index.php?id=ww_flood**Expiration:** October 1, 2018, 23:59 CDT**(Outcome: Yes)****Market #16****Topic:** Disasters**Bet:** Will there be more than 12 fires burning in California by November 15, 2018?**Source:**https://www.google.com/maps/d/u/0/viewer?mid=1ZpcZ8OMZh1G1XwRmt9GaCwH6f-g&hl=en_US**Expiration:** November 15, 2018, 23:59 EST**(Outcome: No)**

Market #17**Topic:** Electricity**Bet:** Will the flow of water through the Hoover Dam rise above 20,000 CBS on November 9, 2018?**Source:** <http://www.usbr.gov/lc/region/g4000/hourly/yester.html>**Expiration:** November 9, 2018, 23:59 EST**(Outcome: Yes)****Market #18****Topic:** N₂O levels**Bet:** Would the Daily Average Nitrous Oxide, N₂O, measured at Barrow, Alaska on October 15, 2018 exceed its value at this time last year?**Source:**<https://www.esrl.noaa.gov/gmd/dv/iadv/graph.php?code=BRW&program=ccgg&type=ts>**Expiration:** October 15, 2018, 23:59 EDT**(Outcome: Yes)****Market #19****Topic:** Weather**Bet:** Will there be 10 or more locations with temperatures above 90 degrees on the U.S. weather map on October 12, 2018?**Source:** <https://weather.com/maps/ustemperaturemap>**Expiration:** October 12, 2018, 23:59 EDT**(Outcome: Yes)****Market #20****Topic:** Weather**Bet:** Will there be more than 8 active extreme heat events globally on October 12, 2018?**Source:** <https://disasteralert.pdc.org/disasteralert>**Expiration:** October 12, 2018, 23:59 EDT**(Outcome: Yes)****Market #21****Topic:** Global Warming**Bet:** Will the Methane level (CH₄) in October 2018 (average between October 1-13) be the highest ever in recorded history?**Source:** <https://www.methanelevels.org>**Expiration:** October 14, 2018, 23:59 EDT**(Outcome: Yes)**

Market #22

Topic: Wildlife

Bet: Will the number of European Honeybee (*Apis mellifera*) be below 500 million beehives by November 2018?

Source: <http://biology.stackexchange.com>

Expiration November 1, 2018, 00:01 CST

(Outcome: No)

Table T1. Study 1 climate markets examples.

Measures

Out of a large number of items captured in the Pre- and Post-surveys we focused on analyzing those pertaining to climate concern, support, and knowledge. Additional variables were captured but not used in this work. **Table T2** shows the items used in the analyses and **table T8** lists the remaining items captured for future works.

Climate concern (*reverse coded*)

§ Global warming refers to the idea that the world's average temperature has been increasing over the past 150 years and may be increasing more in the future. Do you think that global warming is happening? [1 (*Definitely happening*) — 7 (*Definitely not happening*)]

§ If global warming is happening, to what extent do you think it is caused by human activities, as opposed to natural changes in the environment? [0 (*Does not apply because I don't believe it is happening*), 1 (*Definitely caused by human activities*) — 7 (*Definitely naturally caused*)]

§ How much risk do you believe global warming poses to human, health, safety, and prosperity? [0 (*It is not occurring*), 1 (*Extremely high risk*) — 7 (*Although it is occurring there is no risk at all*)]

Climate knowledge (Questions appearing in both *Pre-* and *Post-* surveys) [**Bold** text marks correct answer]

1. Electrons are smaller than atoms. [**True/False**]
2. Which gas makes up most of Earth's atmosphere? [*Hydrogen, Nitrogen, Carbon Dioxide, Oxygen*]
3. There is broad consensus among climate scientists that the increase of atmospheric carbon dioxide associated with the burning of fossil fuels will reduce photosynthesis by plants [**True/False**]
4. Climate scientist believe that if the North Pole icecap melted as a result of human-caused global warming, global sea levels would rise [**True/False**]
5. In the context of climate change, what does IPCC stand for? [*International Plan for Combatting Calamity, International Plan for Climate Catastrophe, Intergovernmental Panel on Climate Change, International Panel on Climate Change*]
6. Which greenhouse gas reached levels of 400 parts per million this year? [**Carbon Dioxide, Nitrous Oxide, Water vapour, Methane**]
7. Which country has the highest overall CO₂ emissions? [*USA, UK, China, North Korea*]

8. What's the name of the international climate treaty that was signed by most countries in 2016? [*Sydney Protocol, Sao Paulo Protocol, Paris Agreement, Kyoto Protocol, Copenhagen Protocol*]
9. As of July 2018, what percent of California was under severe drought? [More than 87%, 36% to 63%, **Less than 25%**, 100%]
10. Senator Sanders, Secretary Clinton, and Mr. Trump all have different views on climate change, please order them from 1 to 3 (1=strongly believe in climate change) [**Sanders > Clinton > Trump**]
11. In 2017, what was the average temperature in the U.S.? [44.7°F, 49.3°F, **54.6°F**, 56.2°F]
12. Rank the following topics by their relevance to climate change [**CO₂ emission > Fracking > Drilling in Alaska**]
13. Which of the following are vital signs of climate change? (Select all that apply) [**Sea level rise, Global temperature rise, Shrinking ice sheets, Declining Arctic sea ice, Glacial retreat, Ocean acidification, Increase in bug populations, Decreased snow cover, Warming oceans**]
14. In 2017 how many acres of land were burned by wildfires in the United States? [1.4 million acres, **10 million acres**, 13 million acres, 20 million acres]
15. Which uses the most electricity in the average U.S. home? [Water heater, Refrigerator, **Heating and air conditioning**, Lights]
16. What is the average days per year with precipitation in Chicago? [90, **120**, 130, 160]
17. Which of the following statements is true about rising sea levels (Select all that apply) [**Rises in sea level have increased the risk of flooding for millions to hundreds of millions of people around the world; In the last 140 years the global sea level has raised on average of 9 inches and has already put many homes, beaches, roads, and wildlife at risk; By the year 2100 the sea level is expected to rise another 1.5 to 3 feet; Rising sea levels will make coastal storms and the associated storm surges more frequent and destructive; By 2100 the sea level is expected to rise another 6 to 8 feet., In the last 10 years there have been 30 percent more storms in the U.S.**]
18. Most earthquakes occur along or near the edges of what location? [North American plate, Earth's ocean and lakes, Eurasian plate, **Earth's lithospheric plates**]
19. Weather and climate refer to conditions [In the core of the Earth, **In the air**, Inside the science lab, In empty space]
20. A heavy snowstorm is called a [Thunderstorm, Hurricane, **Blizzard**, Tornado]
21. Which greenhouse gas is the biggest contributor to the greenhouse effect? [**Carbon Dioxide**, Carbon Monoxide, Methane, Nitrous Oxide, Water vapour]
22. What does the UN program REDD stand for? [Ratifying Emissions for the Determination of International Declarations, Recognized Executive for Drought and Disasters, **Reducing Emissions from Deforestation and Forest Degradation**, Realizing that Everything is a Dreadful Disaster]
23. Who proposed the 2C threshold for dangerous climate change, since agreed at international negotiations? [Alden W Clausen, president of the World Bank at the World Economic Forum in 1981, **William Nordhaus, a Yale economist in a paper in 1977**, James Hansen, a NASA scientist to Congress in 1986, German chancellor Angela Merkel at the 1992 UN climate summit in Rio de Janeiro]
24. What proportion of Poland's electricity is generated through coal? [60%, 70%, **80%**, 90%]

25. Which country is the world's biggest user of renewable energy technologies? [*China, Germany, Morocco, United Kingdom*]
26. What is Earth's average temperature? [*43°F, 50°F, 56°F, 58°F*]
27. What is a fossil fuel? [*Wood, Natural Gas, Hydrogen, Solar energy*]
28. What group of people in the United States have become known as the country's first "climate refugees" and was awarded 52 million for resettlement from the Department of Housing and Urban Development as part of its 1 billion Natural Disaster Resiliency Competition? [*Upper Kuskokwim Tribe, Isle de Jean Charles Tribe, Pee Dee Indian Tribe, Little Shel Tribe of Chippewa Indians*]
29. What state has one of the fastest rates of land loss in the country due to land loss and sea level rise, and has lost 2,000 square miles of land since the 1930s? [*Florida, Louisiana, California, North Carolina*]
30. What is true about the Beaufort and Chukchi seas and much of the Eurasian coast? [*The ice cover remains fairly extensive, especially compared to recent summers, Compared to the 1981 to 2010 average, ice extent on July 15, 2013 was 1.06 million square kilometers below average, Compared to the 1981 to 2010 average, ice extent on July 15, 2013 was 0.97 million square kilometers below average, Compared to the 1981 to 2010 average, ice extent on July 15, 2013 was 0.82 million square kilometers below average*]
31. What U.S. state signed a law legislation to shore-up the state's backup coastal insurer and reduce the liability of private insurers should a major catastrophe strike the state? [*Florida, Louisiana, California, North Carolina*]
32. What is AQI? [*Aerial Quality Index, Aloe Quantity Index, Alaska Quality Identification, Air Quality Index*]
33. What does D4 mean? [*Abnormally Dry, Moderate Drought, Severe Drought, Extreme Drought, Exceptional Drought*]
34. Which of these are sources of air pollution? (Select all applied) [*PM2.5, PM10, Ozone, Sulfur Dioxide (SO₂), Carbon Monoxide (CO), PM1000*]
35. Which of these are greenhouse gas? (Select all applied) [*Carbon Dioxide (CO₂), Carbon Monoxide (CO), Nitrous Oxide (N₂O), Ozone (O₃)*]
36. What is considered a hazard AQI? [*50, 200, 500*]
37. Have the number of wildfires in California increased from 2017 to 2018? [*Yes/No*]
38. Which of the following countries listed below is more likely to experience earthquakes? [*Turkey, Thailand, Ireland, Canada*]

Climate knowledge (Questions appearing only in Post-survey)

39. Which of the following countries listed below is more likely to experience earthquakes? [*Turkey, Thailand, Ireland, Canada*]
40. Did any coastal water temperature surrounding the U.S. reach the 90s in Oct. 2018? [*Yes, No, I don't know*]
41. What is the Global Warming Index? [*Response to natural drivers of climate change, Response to human induced drivers of climate change, Response to human-induced and natural drivers of climate change, I don't know*]
42. What was included in the cumulative carbon emissions measure? [*Fossil fuel use, cement production and land-use change; Fossil fuel use, land-use change; Fossil fuel use; I don't know*]

43. What is the turbidity of water? [*pH levels of the water, Chlorophyll content of the water, Cloudiness of water, I don't know*]
44. Which of the following would be categorized as an active global hazard? [*Heat wave, Eclipse, Flood, Drop in temperature, I don't know*]
45. What is considered moderate AQI? [*0-50, 51-100, 101-150, 151-200, I don't know*]
46. What is a global average temperature anomaly? [*Monthly highest temperature, Monthly lowest temperature, Departure from a short-term average, Departure from a long-term average, I don't know*]
47. What was the dominant pollutant in Ocean View, Hawaii in the past month? [*CO₂, N₂O, SO₂, PM_{2.5}, I don't know*]
48. What has the global warming index been in this past month? [*1.01-1.015, 1.03-1.037, 1.05-1.055, 1.20-1.30, I don't know*]
49. What was the Methane level in Oct. 2018? (parts per billion) [*1700-1750, 1750-1800, 1800-1850, 1850-1900, I don't know*]
50. Did the Daily Average Nitrous Oxide N₂O measured at Barrow, Alaska in October exceed its value from last year? [*Yes, No, I don't know*]
51. What range does the Daily Average Carbon Dioxide CO₂ measured at Mauna Loa, Hawaii in Oct. 2018 fall in? (parts per million) [*398-400, 400-402, 402-404, 404-406, I don't know*]
52. Did the AQI in South Asia exceed 185 in Oct. 2018? [*Yes, No, I don't know*]
53. What units are greenhouse gas measurements made in? [*pH scale, mEq/L, mol, ppm*]
54. How many wildfires were there in California in 2018? [*4500-4700, 4701-4900, 4901-5100, 5101-5300, I don't know*]
55. What was the estimated cumulative emissions in tons of carbon by Oct. 14th, 2018? [*5.75 billion, 6 billion, 6.25 billion, 7 billion, I don't know*]
56. What was NASA's recorded Global Temperature Anomaly for 2018? [*Approximately 0.6, Approximately 0.7, Approximately 0.8, Approximately 0.9, I don't know*]
57. Did the AQI of air pollution in Shimizukōji, Miyagi-ken, Japan exceed 150 in the past 3 months? [*Yes, No, I don't know*]
58. What years is NASA's global temperature index relative to? [*1900-1950, 1951-1980, 1980-2000, 2000-2015*]
59. Was the weekly average Carbon Dioxide measured at Mauna Loa, Hawaii on the week of Oct. 8, 2018 higher than that of the same week in 2008 (10 years ago)? [*Yes, No, I don't know*]
60. Did any coastal water temperature surrounding the Eastern Gulf of Mexico rise above 85 degrees Fahrenheit in Oct. 2018? [*Yes, No, I don't know*]

Demographics

Gender, Age, Education, Number of Children, Income

Political ideology

§ How liberal/conservative do you see yourself? [1 (*Very liberal*) – 7 (*Very conservative*)]

Table T2. Items in the Pre-/Post-surveys of Study 1 which were analyzed in this work. Text in blue marks the question. Text in black depicts the potential answers in multiple-choice items. Bold text corresponds to the correct answer in knowledge questions.

Study 2

Climate markets

Market #1

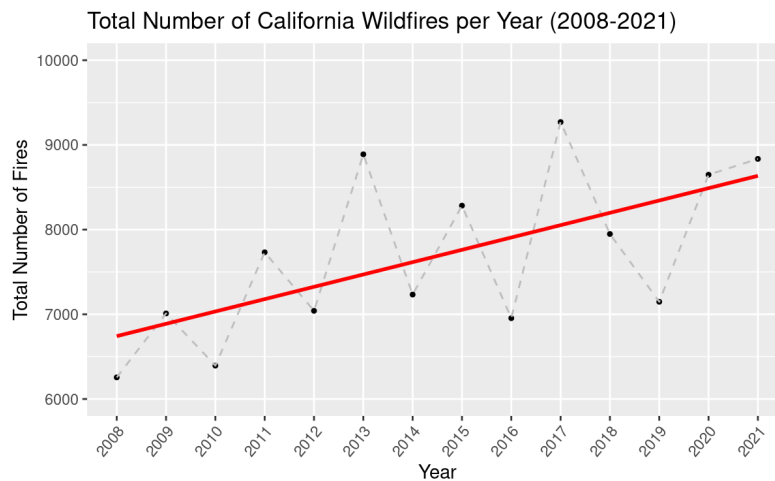
Topic: Wildfires

Bet: Will the number of wildfires in California exceed 5,500 by August 8, 2022 (i.e., Jan. 1, 2022 – Aug. 8, 2022)?

Source: <https://www.fire.ca.gov/incidents/2022/>

Expiration: August 8, 2022, 23:59 EDT

(Outcome: No)



Annual number of California wildfires since 2008

Market #2

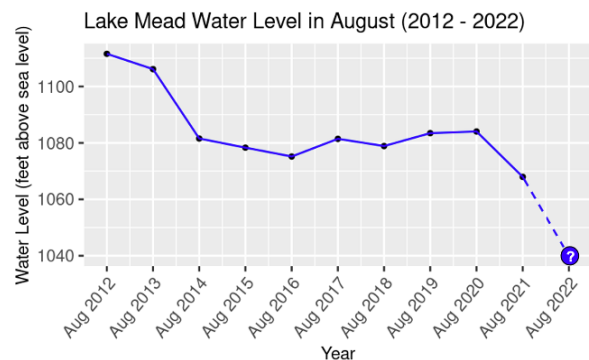
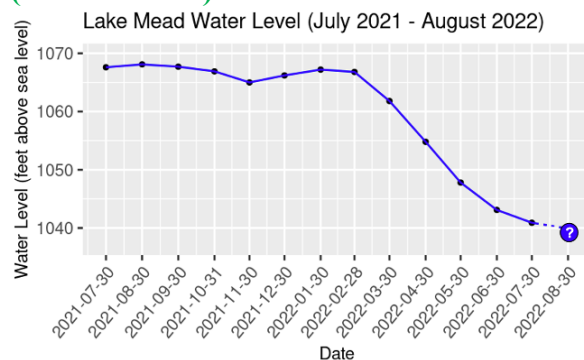
Topic: Great Lakes

Bet: Will the water levels of the Hoover Dam (Lake Mead) fall below 1,039.90 feet by August 30, 2022?

Source: <https://mead.uslakes.info/Level/>

Expiration: August 30, 2022, 23:59 EDT

(Outcome: No)



Market #3

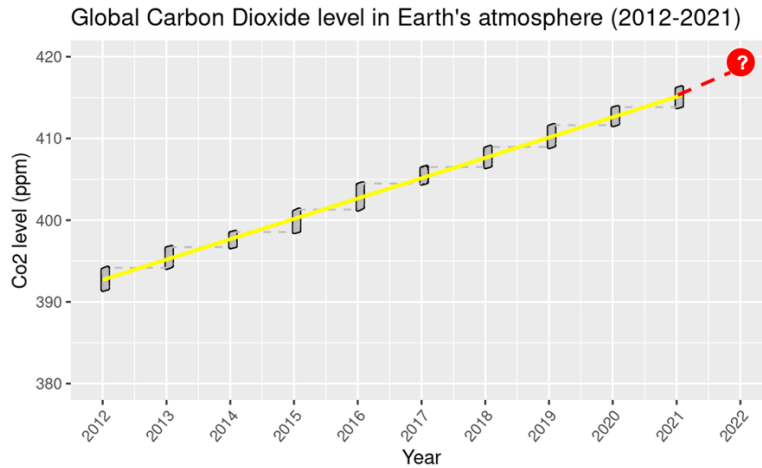
Topic: CO₂

Bet: Will the global average carbon dioxide level in Earth's atmosphere exceed 417.60 parts per million (ppm) between August 5 — August 9, 2022?

Source: https://gml.noaa.gov/ccgg/trends/gl_trend.html

Expiration: August 9, 2022, 23:59 EDT

(Outcome: No)



Global CO₂ level and trend in Earth's atmosphere since 2021

Expiration: August 9, 2022, 23:59 EDT

Market #4

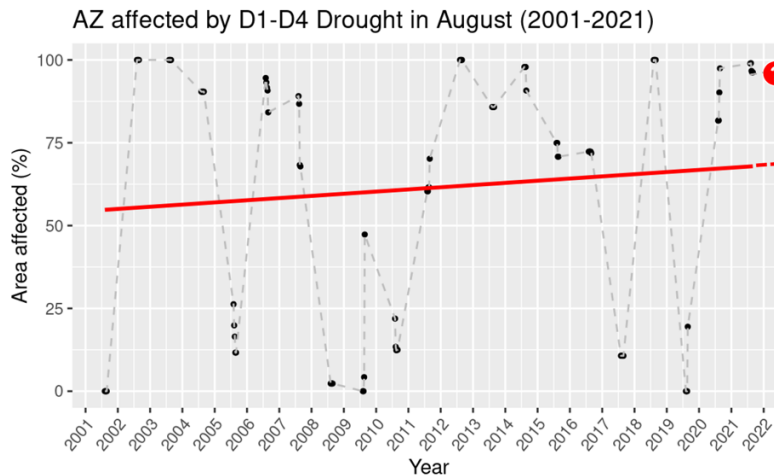
Topic: Droughts

Bet: The U.S. Drought Monitor classifies drought in four levels: Moderate (D1), Severe (D2), Extreme (D3), and Exceptional (D4). Areas that are going into or coming out of drought are considered Abnormally Dry (D0). Will the average percentage area of Arizona affected by “moderate” to “exceptional” drought (D1 – D4) be greater than 95% during the week of August 9-15, 2022 ?

Source: <https://droughtmonitor.unl.edu/DmData/DataDownload/ComprehensiveStatistics.aspx>

Expiration: August 17, 2022, 23:59 EDT

(Outcome: No)



Percentage Area of Arizona affected by Drought in August since 2001

Market #5

Topic: Extreme Heat

Bet: The U.S. National Integrated Heat Health Information System website lists the number of people currently affected by extreme heat advisories, watches, and warnings. Will the number of people in the U.S. under Extreme Heat advisories, watches, and warnings exceed daily average of 90 million between August 5-11, 2022?

Source: <https://www.heat.gov>

Expiration: August 11, 2022, 23:59 EDT

(Outcome: No)

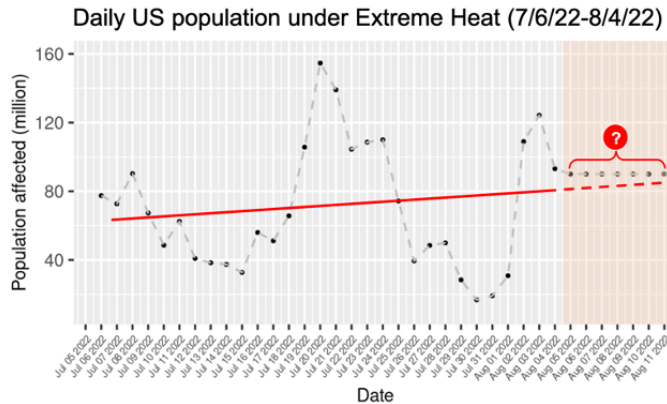


Figure 1

Daily US population (million) in the 48 contiguous states under extreme heat advisories, watches, and warnings

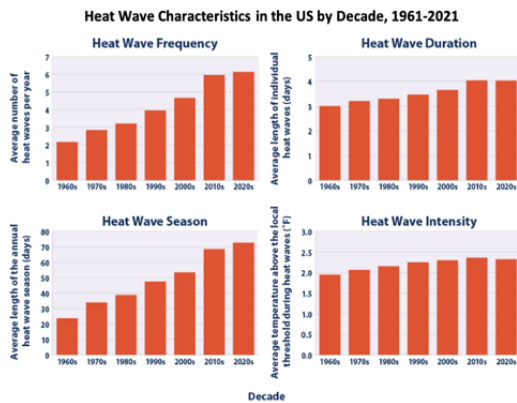


Figure 2

This figure shows changes in the number of heat waves per year (frequency); the average length of heat waves in days (duration); the number of days between the first and last heat wave of the year (season length); and how hot the heat waves were, compared with the local temperature threshold for defining a heat wave (intensity). These data were analyzed from 1961 to 2021 for 50 large metropolitan areas. The graphs show averages across all 50 metropolitan areas by decade.

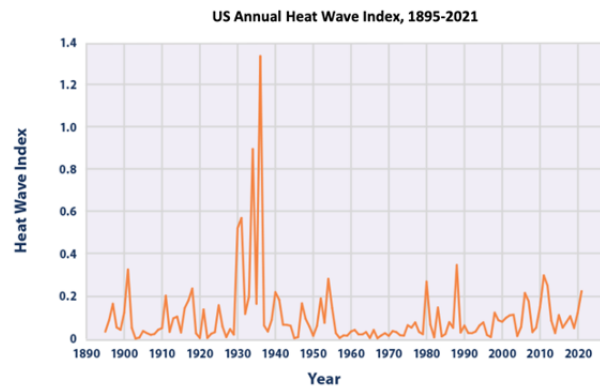


Figure 3

This figure shows the annual values of the U.S. Heat Wave Index from 1895 to 2021. These data cover the contiguous 48 states. An index value of 0.2 (for example) could mean that 20 percent of the country experienced one heat wave, 10 percent of the country experienced two heat waves, or some other combination of frequency and area resulted in this value.

Market #6

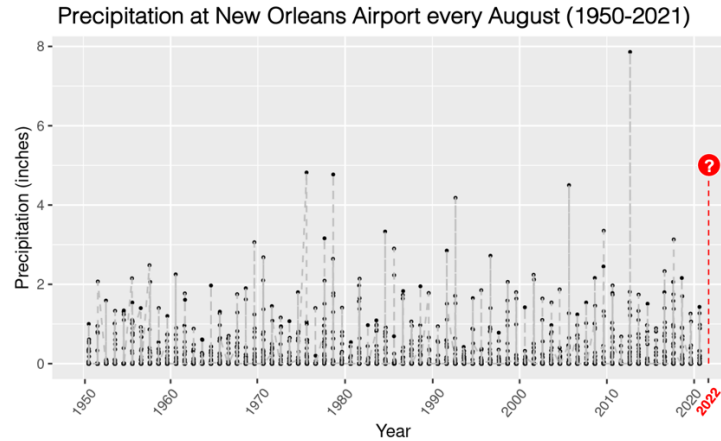
Topic: Precipitation

Bet: The average precipitation (i.e., rainfall) during the summer at the New Orleans International Airport is approximately 5 inches. Will the precipitation measured by the New Orleans Airport station exceed 5.5 inches between August 1 – 28, 2022?

Source: <https://www.ncei.noaa.gov/cdo-web/datasets/ghcnd/stations/ghcnd:usw00012916/detail>

Expiration: August 31, 2022, 23:59 EDT

(Outcome: Yes)



August precipitation amount measured at New Orleans Airport since 1950

Market #7

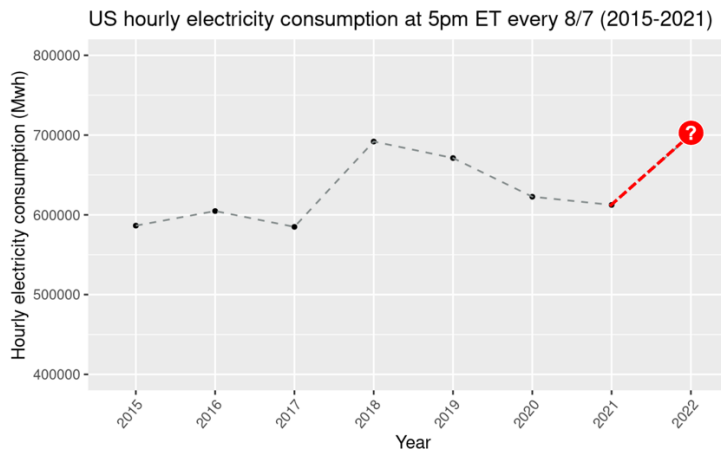
Topic: Electricity Consumption

Bet: The U.S. hourly electricity consumption is highest during the summer, with the daily peak hours occurring between 7am–10pm. According to the data collected between 2015–2019, the hourly peak consumption ranged between 400,000–660,000 Megawatt per hour. Will the hourly electricity consumption in the contiguous U.S. exceed 700,000 Mwh at any hour on August 7, 2022?

Source: https://www.eia.gov/electricity/gridmonitor/dashboard/electric_overview/US48/US48

Expiration: August 7, 2022, 23:59 EDT

(Outcome: No)



U.S. average electricity consumption annually measured at 5pm, August 7, since 2015

Market #8

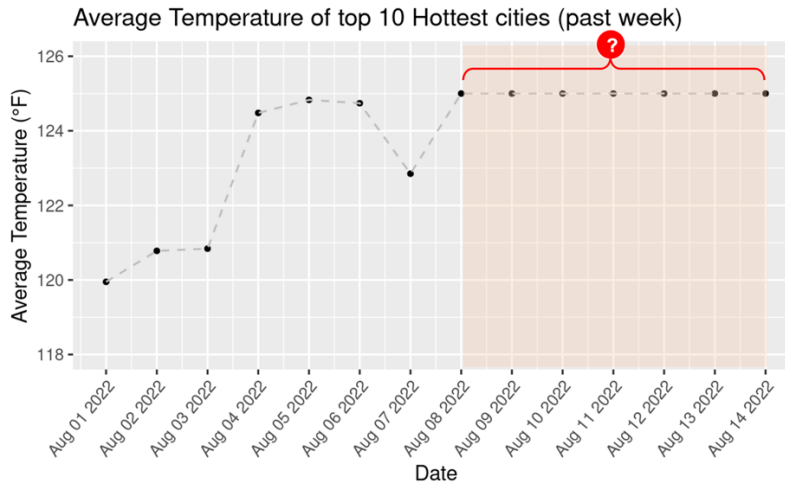
Topic: Extreme Heat

Bet: Will the average temperature of the top 10 hottest cities in the world exceed 125 °F between August 8–14, 2022?

Source: <https://www.eldoradoweather.com/climate/world-extremes2/world-temp-rainfall-extremes.php>

Expiration: August 14, 2022, 23:59 EDT

(Outcome: No)



Average temperature of top 10 Hottest cities between August 1 – 7, 2022

Market #9

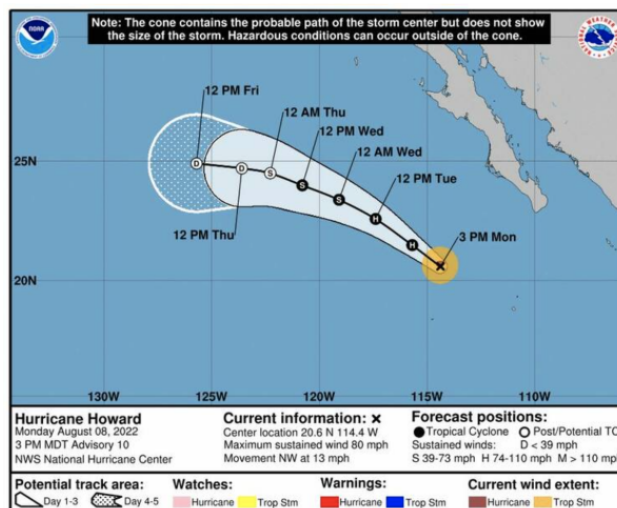
Topic: Hurricanes

Bet: The ‘tropical storm Howard’ intensified into ‘Hurricane Howard’ on August 8, 2022. Will Howard’s maximum sustained winds maintain 50 mph and above until 8pm at August 10, 2022?

Source: <https://zoom.earth/storms/howard-2022>

Expiration: August 10, 2022, 23:59 EDT

(Outcome: No)



Tropical weather outlook for tropical storm Howard on August 8, 2022 (Image reproduced from noaa.gov)

Market #10

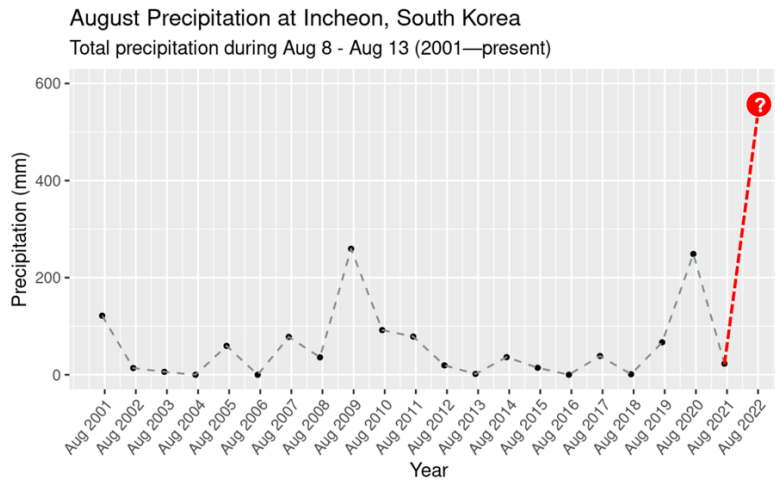
Topic: Floods

Bet: Incheon is a South Korean city near Seoul, that is 51,700 acres in size. The average precipitation (i.e., rainfall) in Incheon during August is approximately 14.4 inches (360mm). Incheon is currently experiencing the worst flood in 80 years. Will the total precipitation exceed 15.7 inches (i.e., 398mm) in Incheon, South Korea between August 8–13, 2022?

Source: <https://www.weather.go.kr/w/obs-climate/land/past-obs/obs-by-day.do?stn=112&yy=2022&mm=8&obs=1>

Expiration: August 13, 2022, 23:59 EDT

(Outcome: No)



August precipitation (mm) measured at Incheon, South Korea since 2001

Market #11

Topic: Power

Bet: According to the Eaton Blackout Tracker Annual Report (2018), significant outages are mainly caused by climate disasters, such as wildfires and thunderstorms. Will the combined ‘state outages’ in California and Texas exceed 15,000 at 8pm ET on August 16, 2022?

Source: <https://poweroutage.us/>

Expiration: August 16, 2022, 23:59 EDT

(Outcome: Yes)

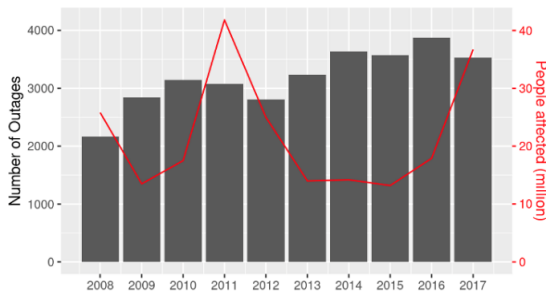


Figure 1. Annual US power outages and the number of people affected (2008-2017)

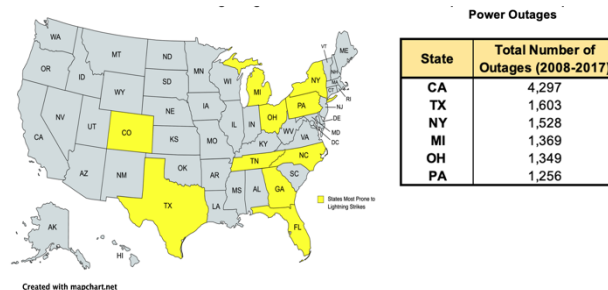


Figure 2. US States prone to lightning strikes and the top 6 states with most power outages (Image reproduced from noaa.gov)

Market #12

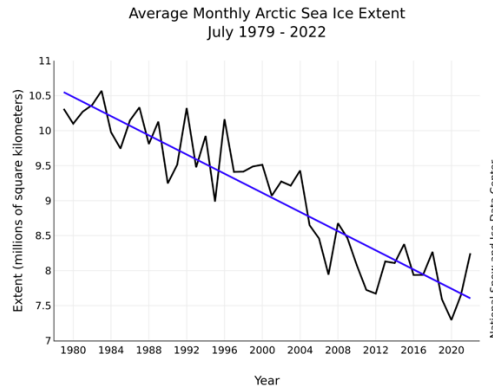
Topic: Arctic Ice

Bet: Will the daily Arctic Sea Ice Extent for the Northern Hemisphere fall below 6.410 (millions of kilometers²) by August 20, 2022?

Source: <http://nsidc.org/arcticseaicenews/charctic-interactive-sea-ice-graph/>

Expiration: August 20, 2022, 23:59 EDT

(Outcome: Yes)



Average monthly Arctic Sea ice extent since July 1979

Market #13

Topic: Hail

Bet: The National Severe Storm Laboratory categorizes hailstorms as severe when the hail stone size is greater than or equal to 1 inch (i.e., hail stone size ≥ 1 inch). There has been increasing trend in the number of severe hailstorms and the size of hail stones. Will there be more than 65 severe hailstorms in the U.S. (i.e., hail stone size ≥ 1 inch) in the days between August 11-21, 2022?

Source: <http://www.stormersite.com/haildate/2022/August/12>

Expiration: August 21, 2022, 23:59 EDT

(Outcome: Yes)

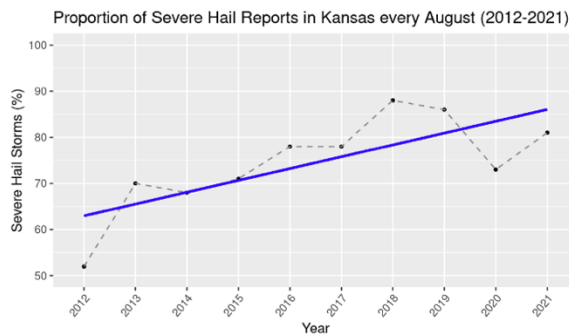


Figure 1. Annual percentage of sever hailstorms (≥ 1) reported out of total hailstorms in Kansas

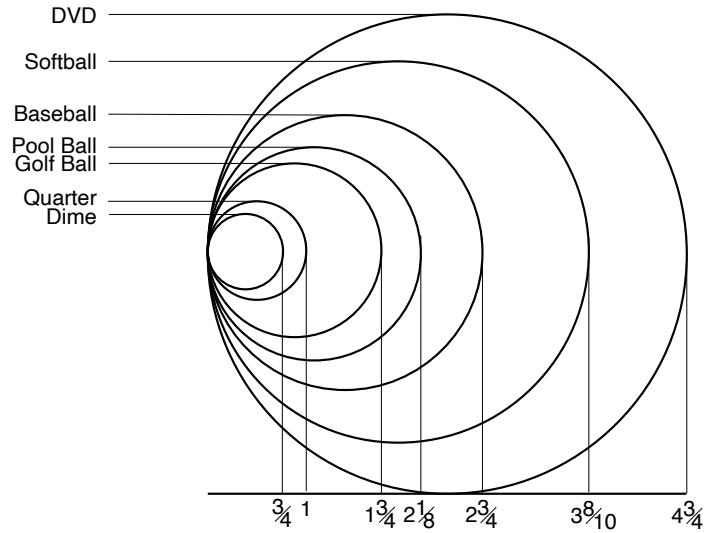


Figure 2. Hail size comparison

Market #14

Topic: Air Quality

Bet: The maximum daily average (24hr) of Particulate Matter 10 (PM10) is $50\mu\text{g}/\text{m}^3$ by California’s Ambient Air Quality Standard. When inhaled, PM10 can accumulate on the lung surface causing respiratory damages. Will there be 3 or more days where the highest daily PM10 exceeds $50\mu\text{g}/\text{m}^3$ at the Los Angeles County between August 14–19, 2022?

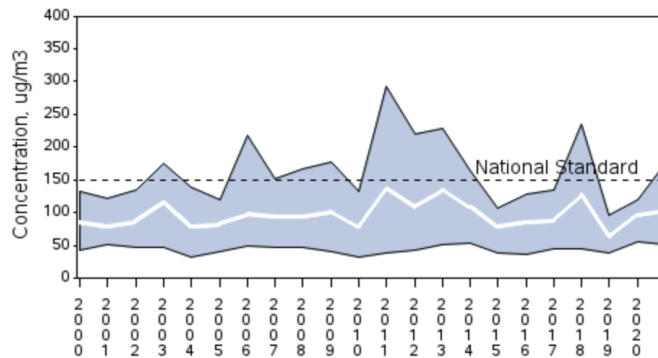
Source:

https://www.arb.ca.gov/aqmis2/display.php?year=2022¶m=PM10_S&units=001&statistic=DMAX&county_name=19-Los+Angeles&basin=--AIR+BASIN--&latitude=--PART+OF+STATE--&std15=&switch=new&hours=all&ptype=aqd&mon=&day=&report=AREA1YR&order=&btnsubmit=Update+Display

Expiration: August 19, 2022, 23:59 EDT

(Outcome: Yes)

PM10 Air Quality, 2000 - 2021
(Annual 2nd Maximum 24-Hour Average)
Southwest Trend based on 31 Sites



2000 to 2021 : 22% increase in Regional Average

PM10 Air Quality concentration ($\mu\text{g}/\text{m}^3$) in the Southwest U.S. since 2000 (Image reproduced from epa.gov)

Market #15

Topic: Natural Hazards

Bet: The U.S. National Risk Index includes 18 types of natural hazards. The Reuters Environment website lists articles related to environmental issues, including ones pertaining to some of the natural hazards. On the Reuters Environment website, will there be 10 or more news headlines pertaining to natural hazards (e.g., drought, wildfire, flood, storm, hail, etc.) published between August 16–18, 2022?

Source: <https://www.reuters.com/business/environment/>

Expiration: August 18, 2022, 23:59 EDT

(Outcome: Yes)

Market #16

Topic: Wildfires

Bet: According to the acres listed on the CAL Fire website, will the estimated acres burned by California wildfires exceed 20,377 acres between August 1st–17th, 2022?

Source: <https://www.fire.ca.gov/incidents/2022/>

Expiration: August 17, 2022, 23:59 EDT

(Outcome: Yes)

Market #17

Topic: Floods

Bet: According to the EPA, flooding frequency has increased around the U.S. coastline where relative sea levels rose quickly. This flooding frequency is measured by streamgages installed near streams, rivers, or bodies of water. Will there be 24 or less streamgages in flood on August 18th, 2022?

Source: https://waterwatch.usgs.gov/index.php?id=2flood:w__table

Expiration: August 18, 2022, 23:59 EDT

(Outcome: Yes)

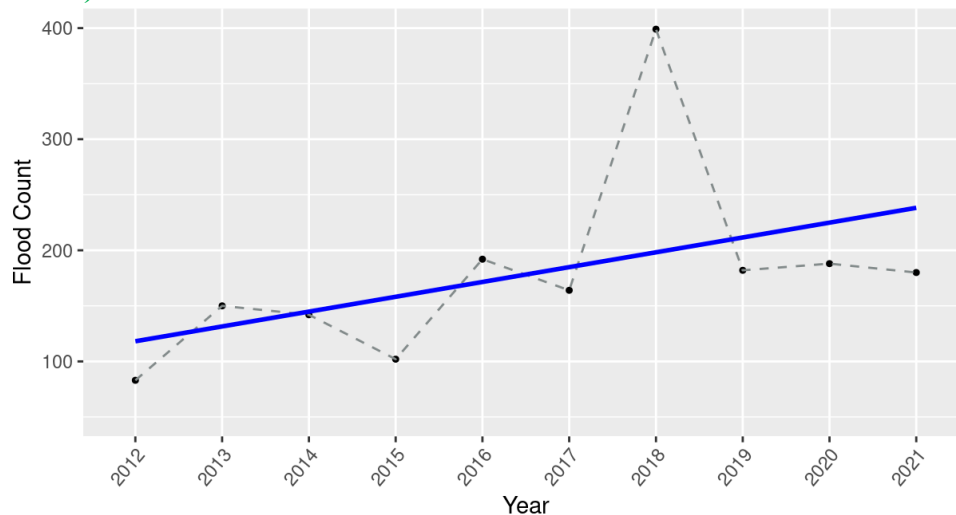


Figure 1. Flood occurrences in the U.S., every August, since 2012

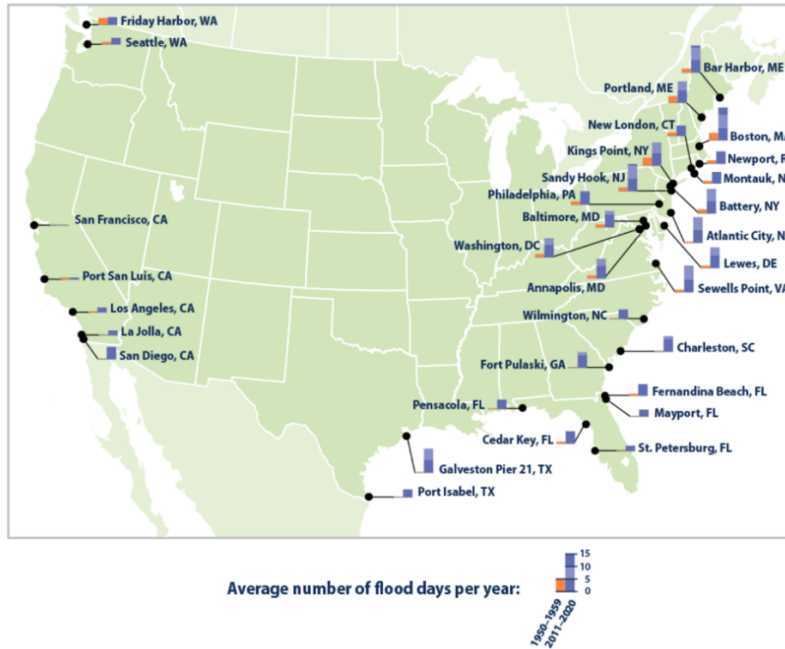


Figure 2. Increasing flood frequency in the U.S. coastlines (1950-1959 versus 2011-2020; Image reproduced from epa.gov)

Market #18

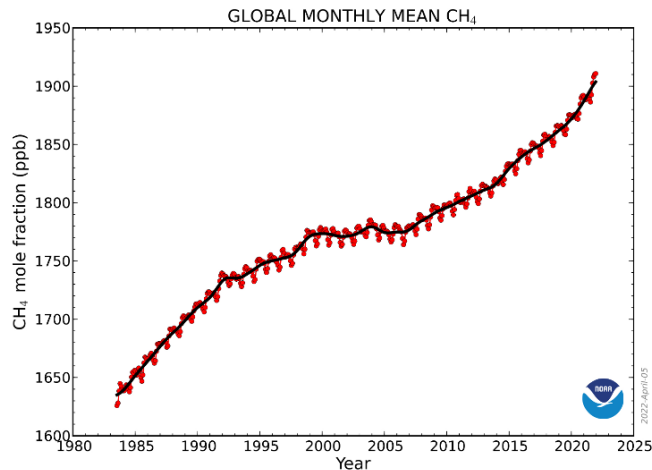
Topic: Methane

Bet: According to the NOAA, methane (CH₄) level in the atmosphere was 1,895.7 (nmol mol⁻¹) in 2021. This is the highest level and fastest acceleration rate ever measured. Will there be 25 or more preliminary measurements that exceed methane level of 1,920 (nmol mol⁻¹) collected by ‘Aircraft 7000m high’ at the ‘Offshore Cape May’ station by August 19th, 2022 (i.e., Jan 1–Aug 19th, 2022)?

Source: <https://gml.noaa.gov/dv/iadv/graph.php?code=CMA&program=ccgg&type=ts>

Expiration: August 19, 2022, 23:49 EDT

(Outcome: Yes)



Monthly mean of methane (CH₄) level in the global atmosphere since 1983 (Image reproduced from noaa.gov)

Market #19

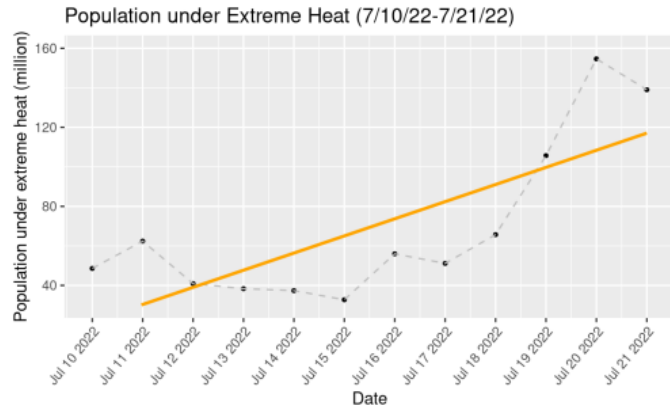
Topic: Extreme Heat

Bet: According to the U.S. Department of Health and Human Services, the heat-related illness rate (HRI Rate) is the rate of heat-related emergency department (ED) visits per 100,000 (ED) visits by region. Will the daily 'HRI Rate' across the contiguous U.S. exceed 900 on August 21st, 2022?

Source: <https://ephtracking.cdc.gov/Applications/heatTracker/>

Expiration: August 21, 2022, 23:49 EDT

(Outcome: No)



Population (millions) under extreme heat between July 10 – 21, 2022

Market #20

Topic: Droughts

Bet: Rhode Island is currently experiencing extreme drought (D3). According to the drought monitor, will 95% or more areas in Rhode Island be in drought (D0–D4) for the week that ends on August 22, 2022?

Source: <https://droughtmonitor.unl.edu/DmData/DataDownload/ComprehensiveStatistics.aspx>

Expiration: August 22, 2022, 23:59 EDT

(Outcome: Yes)

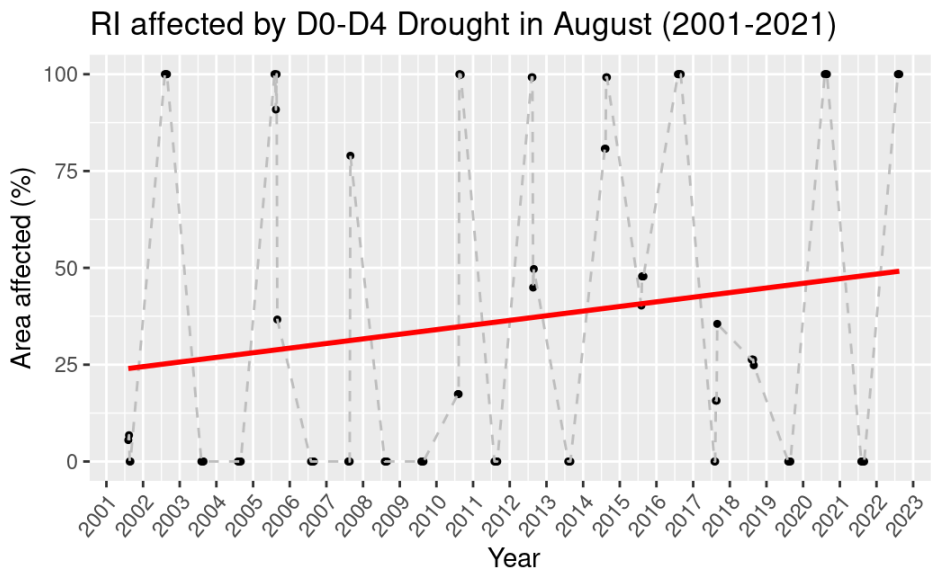


Figure 1. Percentage Area of Rhode Island affected by Drought in August since 2001

| Category | Description | Possible Impacts |
|----------|---------------------|--|
| D0 | Abnormally Dry | Going into drought: <ul style="list-style-type: none"> • short-term dryness slowing planting, growth of crops or pastures Coming out of drought: <ul style="list-style-type: none"> • some lingering water deficits • pastures or crops not fully recovered |
| D1 | Moderate Drought | <ul style="list-style-type: none"> • Some damage to crops, pastures • Streams, reservoirs, or wells low, some water shortages developing or imminent • Voluntary water-use restrictions requested |
| D2 | Severe Drought | <ul style="list-style-type: none"> • Crop or pasture losses likely • Water shortages common • Water restrictions imposed |
| D3 | Extreme Drought | <ul style="list-style-type: none"> • Major crop/pasture losses • Widespread water shortages or restrictions |
| D4 | Exceptional Drought | <ul style="list-style-type: none"> • Exceptional and widespread crop/pasture losses • Shortages of water in reservoirs, streams, and wells creating water emergencies |

Figure 2. Drought Classification according to the U.S. Drought Monitor (Table reproduced from droughtmonitor.unl.edu)

Market #21

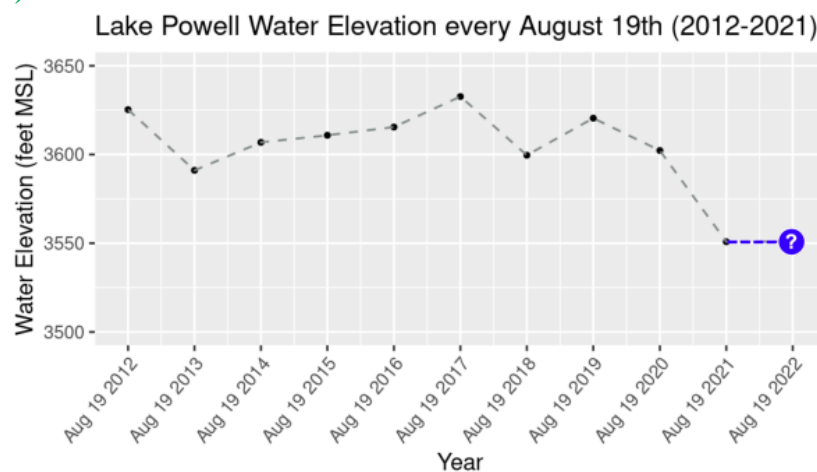
Topic: Great Lakes

Bet: Due to the Colorado river’s record low water level, new water cuts were announced on August 16, 2022. One of the largest reservoirs for the Colorado river is Lake Powell, which is only 25% full as of August 20, 2022. Will Lake Powell’s water elevation remain below 3,550 feet Mean Sea Level by August 27th, 2022?

Source: <https://lakepowell.water-data.com/>

Expiration: August 27, 2022, 23:59 EDT

(Outcome: Yes)



Water elevation of Lake Powell, measured every August 19, since 2020

Market #22

Topic: Floods

Bet: The National Weather Service regularly updates preliminary flood fatalities for each month. By August 28, will the August flood death count be 5 or more?

Source: <https://www.weather.gov/arx/usflood>

Expiration: August 28, 2022, 23:59 EDT

(Outcome: Yes)

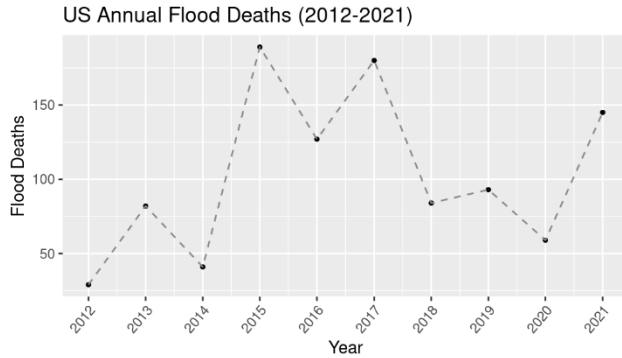


Figure 1. The number of annual deaths caused by flood in the US (2012-2021)

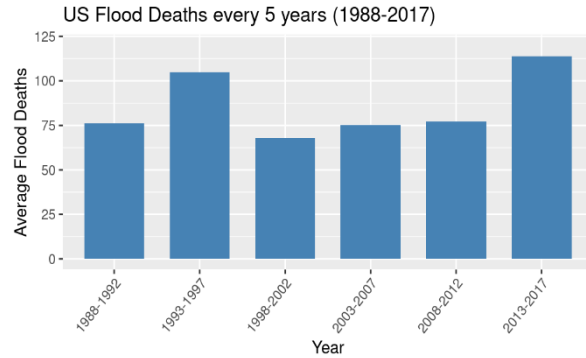


Figure 2. Average flood death toll in the US every 5 years since 1988

Market #23

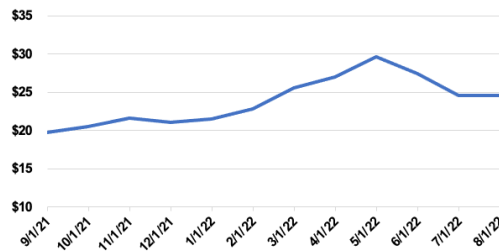
Topic: Economy

Bet: A recent NASA study, published in the journal Nature Food, suggests that climate change will reduce production by 20%. The price of Teucium Corn Fund (NYSEARCA: CORN) has steadily increased from \$21.66 since the study was published. Will the stock price of 1 Teucium Corn Fund maintain above \$21.66 until August 31, 2022?

Source: <https://finance.yahoo.com/quote/CORN/>

Expiration: August 31, 2022, 23:59 EDT

(Outcome: Yes)



Stock price trend of Teucium Corn Fund (CORN) for the past year

Market #24

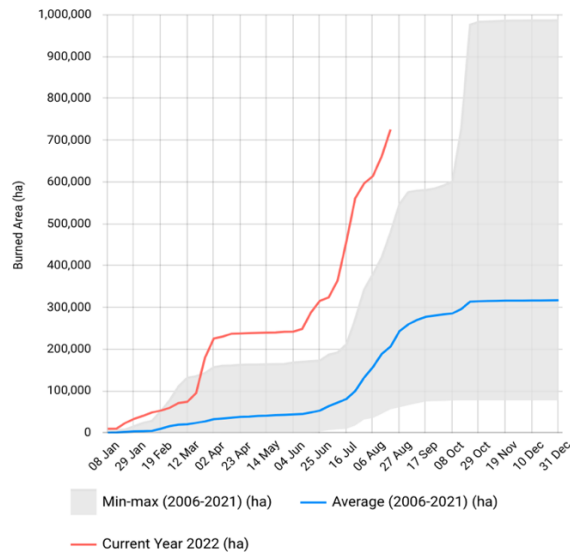
Topic: Wildfires

Bet: The European Forest Fire Information System (EFFIS) website provides weekly information on wildfires across the European Union (EU). By August 27th, will the ‘weekly cumulative burnt areas’ in the EU be 3 times or more than that of the ‘2006-2021 average’?

Source: <https://effis.jrc.ec.europa.eu/apps/effis.statistics/seasonaltrend>

Expiration: August 27, 2022, 23:59 EDT

(Outcome: Yes)



Weekly cumulative areas (ha) burned by wildfires across the European Union (EU)

Market #25

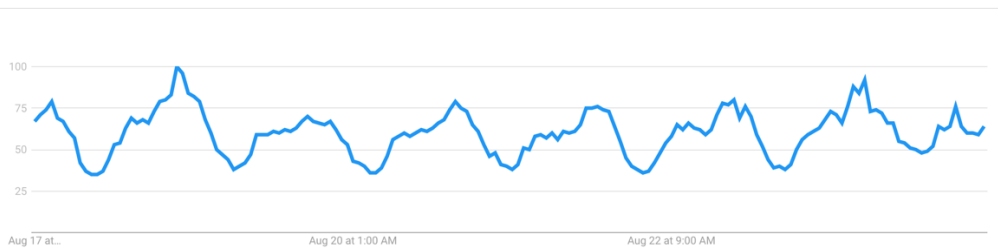
Topic: Droughts

Bet: “Google Trends” shows top search queries in Google Search. Recently, there were multiple record-level droughts around the world that manifested in growing searches for terms related to droughts. Will the worldwide interest in the search term ‘drought’ remain above 50 between 9am–5pm on August 26, 2022? (**The numbers on “Google Trends” represent search interest relative to the highest point on the chart for a given region and time. A value of 100 reflects the peak popularity for a term. A value of 50 means that the term is half as popular. A score of 0 means there was not enough data for this term.)

Source: <https://trends.google.com/trends/explore?date=now%207-d&q=drought>

Expiration: August 26, 2022, 23:59 EDT

(Outcome: No)



Google search trends on the term ‘drought’ since August 17, 2022

Market #26

Topic: Air Quality

Bet: According to a report by the American Lung Association, 98% of Californians live in areas with unhealthy air quality due to vehicle emissions and increasing wildfires. Willow Creek is one of the regions in California with higher Air Quality Index (AQI) values. Will the proportion of days with “good” air quality (0-50 AQI) in Willow Creek, California, be less than 30% in August, 2022?

Source: <https://www.iqair.com/us/usa/california/willow-creek>

Expiration: August 31, 2022, 23:59 EDT

(Outcome: Yes)

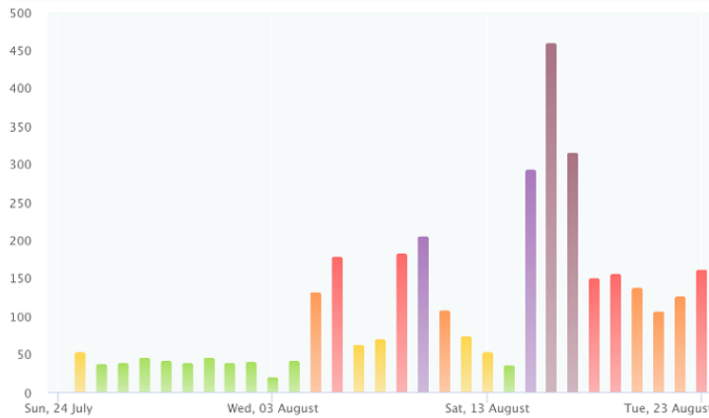


Figure 1. Air Quality Index at Willow Creek, California in the past month

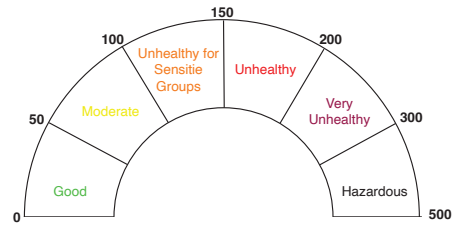


Figure 2. Air Quality Index (AQI)

Market #27

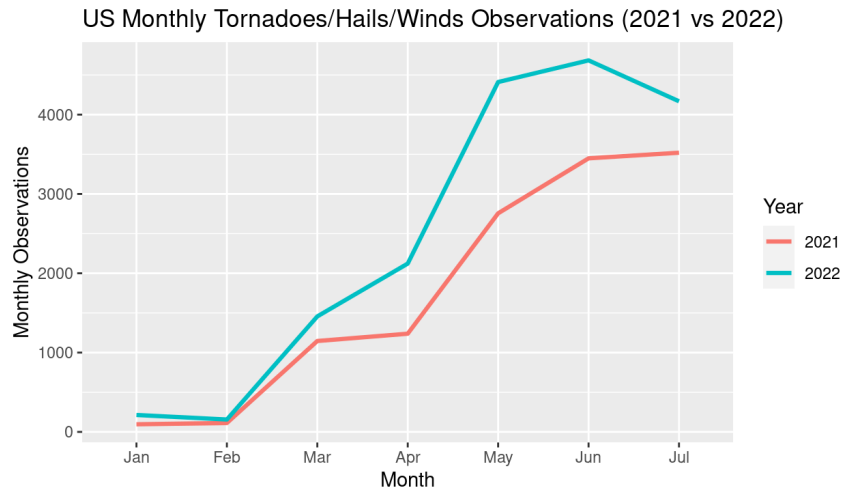
Topic: Storms

Bet: The Storm Prediction Center updates preliminary observations of tornadoes, hails, and winds every Saturday. Will the total number of Tornadoes, Hails, and Winds exceed 1300 for the month of August, 2022?

Source: https://www.spc.noaa.gov/climo/online/monthly/2022_annual_summary.html#

Expiration: September 4, 2022, 23:59 EDT

(Outcome: Yes)



The number of monthly observations of tornadoes/hails/winds in January-July 2021 versus 2022

Market #28

Topic: Droughts

Bet: Extreme droughts have lowered water levels in various locations worldwide. Recently, the declining water levels in the Danube River led to the uncovering of numerous WWII ships sunk there over 70 years ago. Similarly, bodies of people who disappeared decades ago are now found in Lake Mead as the water levels drop. Will there be 1 or more new media items pertaining to record-level droughts uncovering of submerged items worldwide (ships, bodies, ancient relics, etc.) between August 28–31, 2022 (based on the “Google search” for “drought reveals 2022”)?

Source:

<https://www.google.com/search?hl=en&q=drought+reveals+2022&tbm=nws&source=univ&bo=u&sa=X&ved=2ahUKewjqpciG2tv5AhU9pokEHWN2CuoQt8YBegQIAhAF&biw=1373&bih=709&dpr=2>

Expiration: September 1, 2022, 23:59 EDT

(Outcome: No)

Market #29

Topic: Extreme Heat

Bet: The change in temperature was suggested to increase the risk of cardiovascular deaths among people with heart conditions, with most deaths occurring between temperatures 95–109°F. Accordingly, the CDC suggests that the heart disease death rates in Lake Havasu, Arizona are among the highest in the U.S. Will the daily maximum temperature at Lake Havasu, AZ exceed 100°F between August 29–September 1, 2022?

Source: <https://www.ncei.noaa.gov/cdo-web/datasets/GHCND/stations/GHCND:USC00024761/detail>

Expiration: September 3, 2022, 23:59 EDT

(Outcome: Yes)

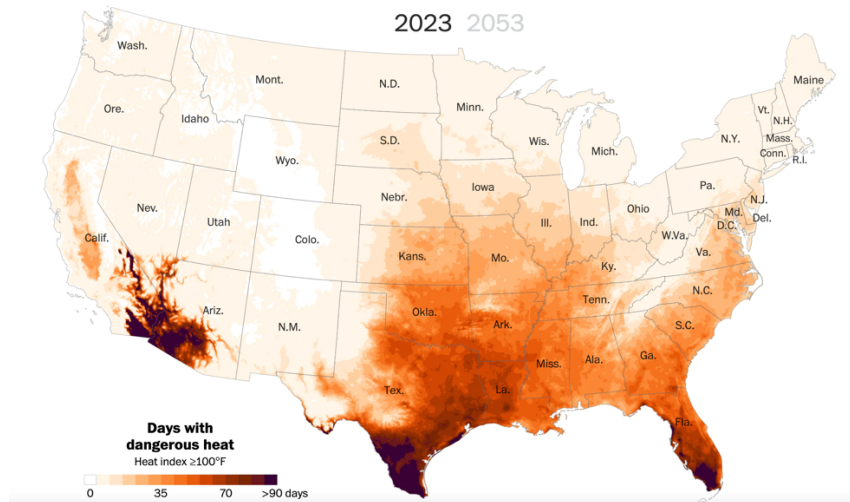


Figure 1. Predicted number of days with dangerous heat levels in 2023 (Image reproduced from cdc.gov)

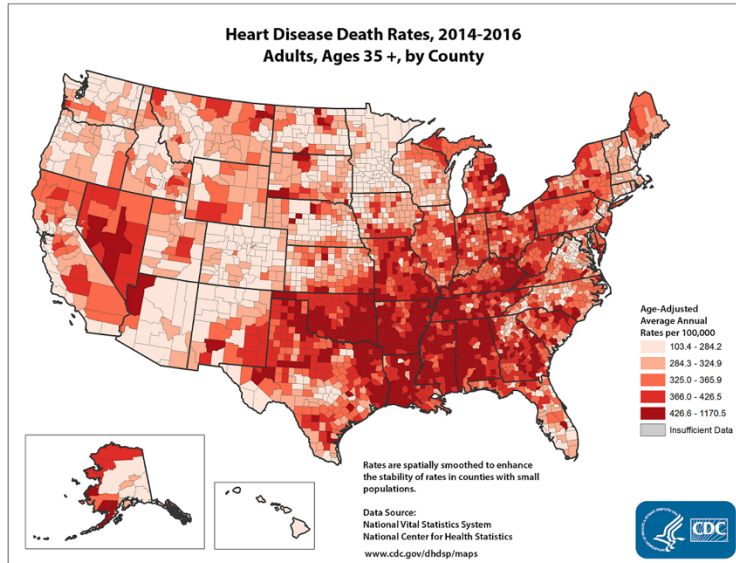


Figure 2. Heart disease death rates between 2014-2016 for adults over 35 years (Image reproduced from cdc.gov)

Market #30

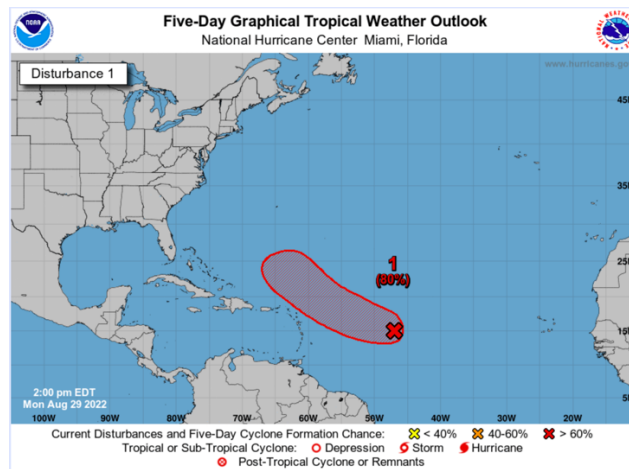
Topic: Hurricanes

Bet: Will the tropical disturbance develop into a 'tropical storm Danielle' by gaining wind speed of over 39 mph by September 2, 2022?

Source: <https://www.nhc.noaa.gov/gtwo.php/>

Expiration: September 2, 2022, 23:59 EDT

(Outcome: Yes)



Tropical weather outlook for tropical disturbance on August 29, 2022

Market #31

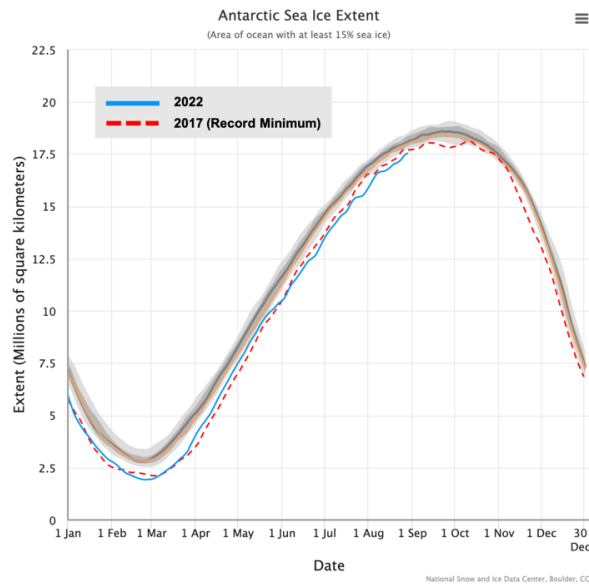
Topic: Antarctic Ice

Bet: Since June 1, 2022, the Antarctic Sea ice extent has been below all previous years. Prior to 2022, the lowest record was observed in 2017. Will the Antarctic Sea ice extent remain lower than the lowest record (2017) until September 2nd?

Source: <http://nsidc.org/arcticseaicenews/charctic-interactive-sea-ice-graph/>

Expiration: September 2, 2022, 23:59 EDT

(Outcome: Yes)



Antarctic Sea ice extent in 2022 versus 2017 (record minimum)

Market #32

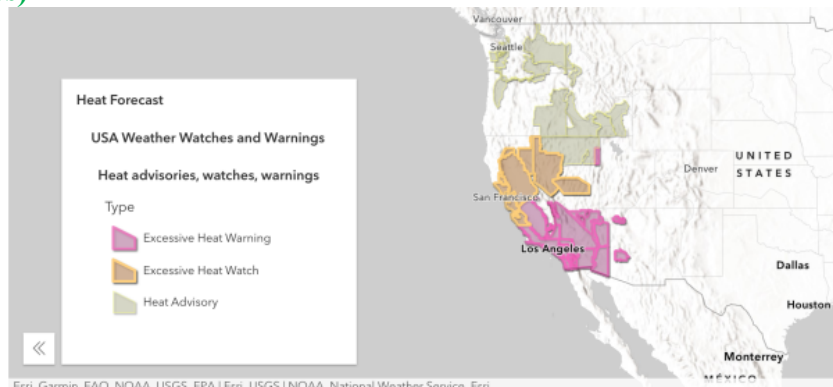
Topic: Extreme Heat

Bet: On August 30, 2022, excessive heat warnings were issued across Southern California. According to the National Weather Service, those heat warnings are expected to reflect the hottest heat wave in California in 2022. Will the number of broken records for 'highest maximum temperature' in California be more than 20 between August 30–September 3?

Source: <https://www.ncdc.noaa.gov/cdo-web/datatools/records>

Expiration: September 6, 2022, 23:59 EDT

(Outcome: Yes)



Excessive heat warning issued in California (Image reproduced from heat.gov)

Market #33

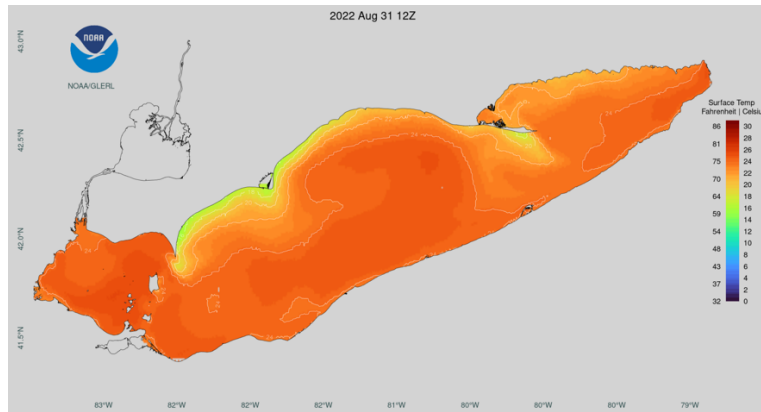
Topic: Great Lakes

Bet: The temperature of the lake surface is recognized internationally as an Essential Climate Variable (ECV). An ECV is a variable that critically contributes to the Earth’s climate. Since 1985, “summer surface water temperature” have increased in 94% of the lakes studied by the EPA. 71% of the lakes had their summer surface temperature increase by more than 1°F, and 44% of the lakes over 2°F. Will more than 50% of Lake Erie’s surface water temperature remain above 68°F (20°C) on September 4, 2022?

Source: <https://www.glerl.noaa.gov/res/glcfs/ncast.php?lake=eri>

Expiration: September 4, 2022, 23:59 EDT

(Outcome: Yes)



Lake Erie’s surface water temperature on August 31, 2022 (Image reproduced from noaa.gov)

Market #34

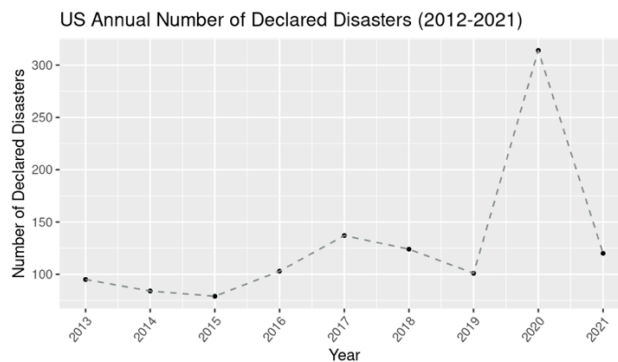
Topic: Disasters

Bet: The Federal Emergency Management Agency (FEMA) website has a list of “declared disasters.” Disasters are declared when a jurisdiction’s chief public officer releases a formal statement indicating that a disaster/emergency in their jurisdiction exceeds their response capabilities, often leading to federal assistance in handling the disaster. Thus far, there have been 61 declared disasters in 2022. Will the FEMA website add 1 or more declared disasters in the U.S. between September 3rd –September 6th?

Source: <https://www.fema.gov/disaster/declarations>

Expiration: September 6, 2022, 23:59 EDT

(Outcome: Yes)



The number of annual declared disasters in the U.S. (2012-2021); (Image reproduced from fema.gov)

Market #35

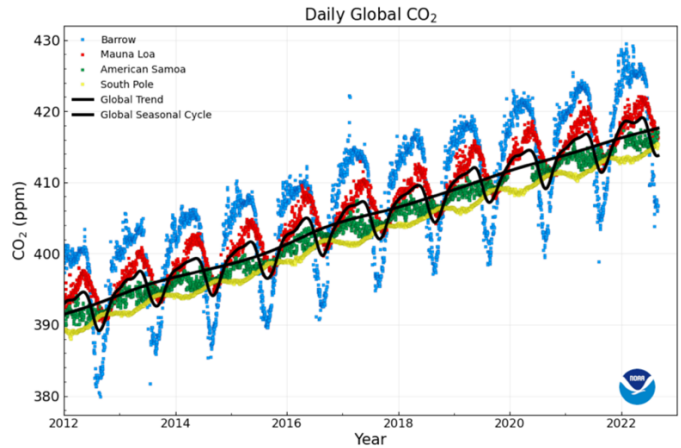
Topic: CO₂

Bet: On August 31, 2022, the international annual review of the world’s climate reported that greenhouse gases in 2021 were the highest ever recorded. The global annual average atmospheric carbon dioxide (CO₂) concentration was 414.7 parts per million (ppm). Will the global average carbon dioxide (CO₂) level in Earth's atmosphere exceed 417.64ppm between September 4–6, 2022?

Source: https://gml.noaa.gov/ccgg/trends/gl_trend.html

Expiration: September 6, 2022, 23:59 EDT

(Outcome: No)



Daily Global CO₂ levels since 2012 (Image reproduced from noaa.gov)

Sports/Entertainment markets

Market #1

Topic: Billboard top 100

Bet: The song 'Heat Waves' was released by an English group 'Glass Animals' on June 29, 2020, and has been on the top 10 Billboard Chart for 79 weeks. Will it fall below the top 10 Billboard Chart by August 8, 2022?

Source: <https://www.billboard.com/charts/hot-100/>

Expiration: August 8, 2022, 23:59 EDT

(Outcome: Yes)

Market #2

Topic: Instagram

Bet: Kim Kardashian ranks on the top 10 Instagram Users by follower count. Will the number of her followers exceed 329,800,000 by August 30, 2022?

Source: <https://www.socialtracker.io/instagram/kimkardashian/>

Expiration: August 30, 2022, 23:59 EDT

(Outcome: No)

Market #3

Topic: Golf

Bet: The Wyndham Championship 2022 is a golf tournament on the PGA Tour held in North Carolina from August 3-7, 2022. Will the defending champion Kevin Kisner rank in the top 3?

Source: <https://www.usopen.com/scoring.html>

Expiration: August 9, 2022, 23:59 EDT

(Outcome: No)

Market #4

Topic: Film

Bet: The new Minions film 'Minions: The Rise of Gru' premiered in the U.S. on July 1, 2022. Will the domestic box office earnings of 'Minions: The Rise of Gru' gross over \$21 million USD between August 9 — 15, 2022?

Source: https://www.boxofficemojo.com/release/rl1736214017/?ref_=bo_gr_rls

Expiration: August 17, 2022, 23:59 EDT

(Outcome: No)

Market #5

Topic: Netflix show

Bet: Will the total number of hours spent on watching 'Stranger Things 4' (in all languages) exceed 1,390,100,000 by August 11, 2022?

Source: <https://flixpatrol.com/streaming-services/most-hours-first-month/netflix/#toc-tv-shows>

Expiration: August 11, 2022, 23:59 EDT

(Outcome: No)

Market #6**Topic:** Chess**Bet:** The Saint Louis Rapid & Blitz 2022 Chess Tournament runs from August 24 to 31. Will Ian Nepomniachtchi's rapid chess rating exceed 2850 on August 31, 2022?**Source:** <https://www.chess.com/ratings>**Expiration:** August 31, 2022, 23:59 EDT**(Outcome: No)****Market #7****Topic:** Twitter**Bet:** Will Elon Musks' average likes per Tweet on Twitter exceed 125,000 by August 7, 2022?**Source:** <https://www.socialtracker.io/twitter/elonmusk/>**Expiration:** August 7, 2022, 23:59 EDT**(Outcome: Yes)****Market #8****Topic:** Soccer**Bet:** Will Tottenham beat Chelsea by more than 1 goal in the Premier League match scheduled on August 14, 2022?**Source:** <https://www.premierleague.com/results>**Expiration:** August 14, 2022, 23:59 EDT**(Outcome: No)****Market #9****Topic:** Guinness Record**Bet:** Will the Guinness World Records website publish more than 1 news article about the world records on August 10, 2022?**Source:** <https://www.guinnessworldrecords.com/news/latest-news>**Expiration:** August 10, 2022, 23:59 EDT**(Outcome: No)****Market #10****Topic:** Twitch**Bet:** Will the 7-day (between August 7–August 13) average number of viewers watching the game 'League of Legends' on Twitch exceed 190,000 on August 13, 2022?**Source:** <https://twitchtracker.com/games/21779>**Expiration:** August 13, 2022, 23:59 EDT**(Outcome: No)****Market #11****Topic:** Netflix Film**Bet:** Will the Netflix film 'Purple Hearts' remain rank #1 in the top 10 films in the U.S. by August 14, 2022?**Source:** <https://top10.netflix.com/united-states/tv>**Expiration:** August 16, 2022, 23:59 EDT**(Outcome: No)**

Market #12**Topic:** MMA**Bet:** UFC 278 is an upcoming Mixed Martial Arts event that takes place on August 20, 2022. In the main event, Leon Edwards goes up against Kamaru Usman. Will Usman's total strike landed (TSL) during the game exceed 170 strikes?**Source:** https://www.espn.com/mma/fighter/stats/_/id/3088812/kamaru-usman**Expiration:** August 20, 2022, 23:59 EDT**(Outcome: Yes)****Market #13****Topic:** Swimming Championship**Bet:** The 2022 European Aquatics Championship is taking place in Rome, Italy between August 11–21. Will France rank in the top 3 (by overall medals) in the ‘Diving’ category by August 21, 2022?**Source:**https://roma2022.microplustimingservices.com/indexRoma2022_web.php?s=TG9hZE92ZXJhbGxNZWRhbCgpOw==&cat=&page=&spec=&bat=&td=CAL_CIS_DAY&hg=&descIT=&descEN=&descFR=&curCatSel_M_F=&sport=Diving**Expiration:** August 21, 2022, 23:59 EDT**(Outcome: No)****Market #14****Topic:** Instagram**Bet:** Will Leo Messi's number of Instagram posts exceed 893 by August 19, 2022?**Source:** <https://www.socialtracker.io/instagram/leomessi/>**Expiration:** August 19, 2022, 23:59 EDT**(Outcome: Yes)****Market #15****Topic:** Horse Racing**Bet:** Multiple horse races are held at the Del Mar Thoroughbred Club. Will ‘Rancho Red’ rank in the top 3 for Race 1 held on August 18th, 2022?**Source:** <https://www.dmtc.com/racing/results/2022-08-18>**Expiration:** August 18, 2022, 23:59 EDT**(Outcome: No)****Market #16****Topic:** Women's soccer**Bet:** The 2022 FIFA U-20 Women's World Cup is held in Costa Rica between August 10–18, 2022. Will U.S. score more than 2 goals against Japan on August 17th, 2022?**Source:** <https://www.ussoccer.com/competitions/fifa-u20-womens-world-cup-2022/matches/united-states-vs-japan-8-17-22>**Expiration:** August 17, 2022, 23:59 EDT**(Outcome: No)**

Market #17**Topic:** Amazon Best Seller**Bet:** Amazon's Best Seller Book List shows most popular books based on sales. Will Eric Carle's 'The Very Hungry Caterpillar' remain in the top 25 of the Best Seller list at 23:59 EST on August 18, 2022?**Source:** <https://www.amazon.com/gp/bestsellers/books>**Expiration:** August 18, 2022, 23:59 EDT**(Outcome: Yes)****Market #18****Topic:** YouTube**Bet:** Blackpink, a female K-pop group, is releasing their newest single "Pink Venom" at 12am ET on August 19th, 2022. Will Blackpink's "Pink Venom" music video exceed 62 million views on their official YouTube channel within 24 hours (i.e., 23:59 EST on August 19, 2022)?**Source:** <https://www.youtube.com/c/BLACKPINKOFFICIAL/videos>**Expiration:** August 19, 2022, 23:59 EDT**(Outcome: Yes)****Market #19****Topic:** Billboard top 100**Bet:** The song 'Break my Soul' was released by Beyoncé on June 21, 2022, and currently ranks #1 on the Billboard Hot 100 list for the week of August 20, 2022. Will 'Break my Soul' remain #1 on the Billboard Hot 100 list on August 21, 2022?**Source:** <https://www.billboard.com/charts/hot-100/>**Expiration:** August 21, 2022, 23:49 EDT**(Outcome: No)****Market #20****Topic:** Golf**Bet:** The 2022 BMW Championship is a golf tournament on the PGA Tour held in Delaware from August 18–21, 2022. Will the defending champion Patrick Cantlay's number of strokes (i.e., golf swings) be 68 or more during Round 4 ("R4")?**Source:** <https://www.golfchannel.com/tours/pga-tour/2022/bmw-championship>**Expiration:** August 22, 2022, 23:59 EDT**(Outcome: Yes)****Market #21****Topic:** Volleyball**Bet:** The 2022 FIVB Volleyball Men's World Championship is held between August 26 – September 11, 2022. In pool C, will team USA win the match against Mexico on August 26, 2022?**Source:** <https://en.volleyballworld.com/volleyball/competitions/men-world-championship-2022/schedule/#2022-08-26>**Expiration:** August 27, 2022, 23:59 EDT**(Outcome: Yes)**

Market #22**Topic:** F1**Bet:** The 2022 Belgian Grand Prix is a Formula One motor race held on August 28th, 2022. Will the time gap between the first ranking driver and the second ranking driver exceed 2 seconds?**Source:** <https://us.motorsport.com/f1/results/2022/hungarian-gp-538750/>**Expiration:** August 28, 2022, 23:59 EDT**(Outcome: Yes)****Market #23****Topic:** Film**Bet:** The movie 'Dragon Ball Super: Super Hero' was released on August 19th, 2022, and earned \$20 million in the box office on its debut. Will the movie 'Dragon Ball Super: Super Hero' gross over 41 million USD by August 31, 2022?**Source:** https://www.boxofficemojo.com/release/rl349471489/?ref=bo_hm_rd**Expiration:** August 31, 2022, 23:59 EDT**(Outcome: No)****Market #24****Topic:** Overwatch**Bet:** 'Overwatch' is a popular first-person shooter game that is very popular in e-sport tournaments. Will the 'New York Excelsior' win the Overwatch match against 'San Francisco Shock' by 2 or more points on August 26, 2022?**Source:** https://www.overwatchleague.com/en-us/schedule?stage=regular_season&week=17&team=allteams**Expiration:** August 27, 2022, 23:59 EDT**(Outcome: No)****Market #25****Topic:** NFL**Bet:** The National Football League (NFL) is currently in a 3 week-long preseason period, where NFL teams play exhibition games for training purposes. Will the "New England Patriots" win against "Las Vegas Raiders" by 3 or more points in the NFL preseason match?**Source:** <https://www.nfl.com/schedules/2022/PRE3/>**Expiration:** August 26, 2022, 23:59 EDT**(Outcome: No)****Market #26****Topic:** TikTok**Bet:** Jason Derulo is an American singer who is very active on social media. Will Jason Derulo's uploads on TikTok exceed 797 posts by August 31, 2022?**Source:** <https://socialblade.com/tiktok/user/jasonderulo>**Expiration:** August 31, 2022, 23:59 EDT**(Outcome: No)**

Market #27**Topic:** Netflix show**Bet:** The Netflix TV series 'Instant Dream Home: Season 1' has been listed on Netflix's U.S. Top 10 for 1 week. Will it continue to stay in the 'US top 10' by September 4, 2022?**Source:** <https://top10.netflix.com/united-states/tv>**Expiration:** September 4, 2022, 23:59 EDT**(Outcome: No)****Market #28****Topic:** Tennis**Bet:** The U.S. Open tennis tournament is held between August 29 to September 12, 2022. Will J.Isner win against F.Delbonis in the First Round of the Men's Singles match held on August 30, 2022?**Source:** https://www.usopen.org/en_US/scores/schedule/schedule8.html**Expiration:** September 1, 2022, 23:59 EDT**(Outcome: Yes)****Market #29****Topic:** Water Polo**Bet:** The 2022 European Water Polo Championship is held between August 26–September 9, 2022. Will Spain win against Germany in the water polo qualification match held on September 2, 2022?**Source:** <https://www.flashscore.com/water-polo/europe/european-championship/fixtures/>**Expiration:** September 3, 2022, 23:59 EDT**(Outcome: Yes)****Market #30****Topic:** MLB**Bet:** The 2022 Major League Baseball (MLB) season has started on April 7 and ends on October 5, 2022. Will the New York Mets win against the Washington Nationals by 3 or more points on September 2, 2022?**Source:** <https://www.mlb.com/scores/2022-09-02>**Expiration:** September 2, 2022, 23:59 EDT**(Outcome: Yes)****Market #31****Topic:** YouTube**Bet:** Jack Harlow's "First Class" performance featuring Fergie at the 2022 Video Music Awards (VMA) is currently trending #8 on YouTube Music. Will Jack Harlow's "First Class" performance at the 2022 VMA exceed 1.9 million views by September 2, 2022?**Source:** <https://www.youtube.com/watch?v=Y6aMwTS0EVM>**Expiration:** September 2, 2022, 23:59 EDT**(Outcome: Yes)**

Market #32

Topic: Amazon Best Seller

Bet: Amazon’s Best Seller Book List shows most popular books based on sales. Will James Clear’s ‘Atomic Habits’ remain in Amazon’s top 12 Best Seller list at 23:59 EST on September 6, 2022?

Source: <https://www.amazon.com/gp/bestsellers/books>

Expiration: September 6, 2022, 23:59 EDT

(Outcome: Yes)

Market #33

Topic: Soccer

Bet: Will ‘Arsenal’ win against ‘Manchester United’ in the Premier League match scheduled for September 4, 2022?

Source: <https://www.premierleague.com/match/74966>

Expiration: September 4, 2022, 23:59 EDT

(Outcome: No)

Market #34

Topic: Basketball

Bet: The 2022 FIBA Men’s Eurobasket tournament is a basketball championship organized by FIBA Europe. Will Italy win against Croatia in the “Group A” EuroBasket match on September 6, 2022 by at least 1 points?

Source: <https://www.glerl.noaa.gov/res/glcfs/ncast.php?lake=eri>

Expiration: September 6, 2022, 23:59 EDT

(Outcome: Yes)

Market #35

Topic: Twitter

Bet: Will Taylor Swift’s Twitter followers count exceed 91,070,000 by September 6, 2022?

Source: <https://socialblade.com/twitter/user/taylorswift13>

Expiration: September 6, 2022, 23:59 EDT

(Outcome: No)

Table T3. Study 2 climate markets and sports/entertainment markets.

Measures

Out of a large number of items captured in the Pre- and Post-surveys we focused on analyzing those pertaining to climate concern, support, and knowledge. Additional variables were captured but not used in this work. **Table T4** shows the items used in the analyses and **table T9** lists the remaining items captured for future works.

Climate concern (Questions appearing in both *Pre-* and *Post-* surveys)

§ Global warming refers to the idea that the world's average temperature has been increasing over the past 150 years and may be increasing more in the future. Do you think that global warming/climate change is happening? [1 (*Definitely not*) — 7 (*Definitely yes*)]

§ Do you think global warming/climate change is the result of human activities? [1 (*Definitely not*) — 7 (*Definitely yes*)]

§ How much risk do you believe global warming/climate change poses to human, health, safety, and prosperity? [1 (*None at all*) — 7 (*Extremely high*)]

§ Some people say that global warming/climate change is simply a scam. What do you think about this? [1 (*Strongly disagree*) — 7 (*Strongly agree*)]

Climate support (Questions appearing in both *Pre-* and *Post-* surveys)

§ Addressing global warming/climate change should be a priority of the government. [1 (*Strongly disagree*) — 7 (*Strongly agree*)]

§ I feel personally responsible to help slow down global warming/climate change (e.g., by making changes to my lifestyle or paying higher taxes). [1 (*Strongly disagree*) — 7 (*Strongly agree*)]

§ Some people say that climate change is real, but that the cost of fixing it today might not be worth the investment (i.e., that the cost of fixing it today is higher than the cost of the damages caused by it). How strongly do you agree with this claim (that it is not worth investing resources/money now, to fight climate change)? [1 (*Strongly disagree*) — 7 (*Strongly agree*)]

Climate knowledge (Questions appearing in both *Pre-* and *Post-* surveys) [**Bold** text marks correct answer]

1. A heavy snowstorm is called a — [*Thunderstorm, Hurricane, **Blizzard**, Tornado*]
2. Global warming refers to an increase in which of the following? [**The average surface temperature of the Earth**, *The average temperature of the Earth's atmosphere, The average temperature of Earth's core, The average rate of snow melting on Mount Everest*]
3. Globally, which of the following economic sectors emit the largest percentage of greenhouse gasses? [*Transportation, Manufacturing, **Electricity and heat production**, Agriculture*]
4. Climate scientist believe that if the North Pole icecap melted... [**Global sea levels would rise**, *Honeybees will become extinct, Global sea levels would drop, Arctic ocean temperature would drop by 10 degrees*]
5. How many major layers does Earth's atmosphere have? [3, 5, 7, 9]
6. How much Carbon Dioxide does the average American add to the atmosphere each year? [**20 Metric Tons**, *7.5 Metric Tons, 12 Metric Tons, 16 Metric Tons*]
7. What is Earth's average temperature? [*43 degrees Fahrenheit, 50 degrees Fahrenheit, **56 degrees Fahrenheit**, 58 degrees Fahrenheit*]

8. What is the primary effect of greenhouse gasses? [Trapping the sun's heat inside the Earth's atmosphere, Letting sunlight travel smoothly into and out of Earth's atmosphere, Preventing UV rays from reaching the Earth's surface, Greenhouse gasses serve no real purpose]
9. Which of the following is considered a critical threshold for carbon dioxide levels in the atmosphere? [123 parts per million, 250 parts per million, **400 parts per million**, 600 parts per million]
10. Which renewable energy source contributes the most energy to the United States? [Solar, Wind, Geothermal, Hydropower]

Climate knowledge (Questions appearing in Post-survey only) [Bold text marks correct answer]

1. For the past five years, approximately how many wildfires were reported in California annually? [Approximately 1,000, Approximately 5,000, **Approximately 8,000**, Approximately 12,000]
2. How many levels are used to classify droughts according to the U.S. drought monitor? [3 levels (D0-D2), 4 levels (D0-D3), **5 levels (D0-D4)**, 6 levels (D0-D5)]
3. What is the standard unit measurement of Carbon Dioxide concentration in the air? [Gigajoules (gj), Normal cubic meter (nm3), One thousand cubic feet (mcf), **Parts per million (ppm)**]
4. According to the American Lung Association, which U.S. state has the worst air quality? [Oregon, **California**, Washington, Texas]
5. According to the Environmental Protection Agency (EPA), which U.S. State saw the biggest overall increase in flooding activity? [Utah, Wisconsin, Michigan, **Massachusetts**]
6. What is the correct description for a D0 level drought? [**Abnormally dry**, Moderate drought, Extreme drought, Exceptional drought]
7. According to the U.S. Air Quality Index (US AQI), which AQI is considered 'good'? [**0-50**, 50-100, 150-200, 200+]
8. Hailstorms are considered severe when: [They last for more than 15 minutes, The hailstone fall speed is greater than 15 mph, **The size of the hailstones are greater than or equal to 1 inch (≥ 1 inch)**, The size of the hailstones are greater than or equal to 2 inch (≥ 2 inch)]
9. When does a tropical disturbance become a tropical storm and gains a name? [Minimum sustained wind speed of 21 mph or more, Minimum sustained wind speed of 30 mph or more, Maximum sustained wind speed of 24 mph or more, **Maximum sustained wind speed of 39 mph or more**]
10. What does HRI stand for in the context of climate? [**Heat Related Illness rate**, Heatwave Related Index rate, Health Related Illness rate, Heart Related Index rate]
11. What do you call a structure that is installed near rivers to measure information about water levels, flows, etc.? [Rivergages, **Streamgages**, Water towers, Water posts]
12. Which U.S. State had over 99% of its territory in the state of drought for a full week in August, 2022? [Texas, Colorado, **Rhode Island**, South Dakota]
13. Which greenhouse gas had the highest level in the atmosphere and the fastest growth rate measured this summer? [**Methane (CH₄)**, Carbon monoxide (CO), Nitrogen trifluoride (NF₃), Sulfur hexafluoride (SF₆)]
14. According to the scientific journal Nature Food, which crop is expected to have reduced production due to climate change? [**Corn**, Rice, Soy bean, Wheat]

15. Which city saw a record-level rainfall in August 2022 that caused the most severe flooding in 100 years? [*Arica, Chile; **Incheon, South Korea**; Incheon, Okayama, Japan; Osaka, Japan*]
16. The low water-levels in lakes this summer have revealed various submerged items. Which of the below is not an item that was identified due to the low water-levels? [*Dead bodies, **Tractors**, Stonehenge, WWII ships*]
17. Fill in the blank: A _____ is when a jurisdiction's chief public officer releases a formal statement that a disaster/emergency exceeds response capabilities of the jurisdiction, often leading to federal assistance. [***Disaster declaration**, Federal emergency assistance, Federal disaster cooperation, Disaster intervention*]
18. Which of the following is not considered one of the 18 natural hazards defined by the U.S. National Risk Index? [*Drought, Flood, Lightning, **Heavy rain***]
19. Between 2015-2019, what was the range of hourly peak electricity consumption in July in the US? [*90,000 — 170,000 (Megawatt per hour), 200,000 — 320,000 (Megawatt per hour), 320,000 — 450,000 (Megawatt per hour), **400,000 — 660,000 (Megawatt per hour)***]
20. Which full year was the 'Antarctic Sea' ice extent the lowest ever observed? [*2004, 2012, **2017**, 2019*]

Demographics

Gender, Age, Education, Number of Children, Income

Political ideology

§ How liberal/conservative do you see yourself? [1 (*Very liberal*) – 7 (*Very conservative*)]

Seriousness

§ Thank you very much for taking part in this study! We will send you the bonus payment in the next week. It is critical for us to get a sense of how seriously people took the study. Your answer to this question won't influence your payment in any way. But it will greatly help us guarantee the integrity of our research findings and make the many hours you and others have spent worthwhile. Please tell us how seriously you took the study (e.g., how carefully you read the bets or how much time you spent thinking about them): [1 (*Not seriously at all*) — 10 (*Very seriously*)]

Table T4. Items in the Pre-/Post-surveys of Study 2 which were analyzed in this work. Text in blue marks the question. Text in black depicts the potential answers in multiple-choice items. Bold text corresponds to the correct answer in knowledge questions.

Supplementary Results

Descriptive information for studies

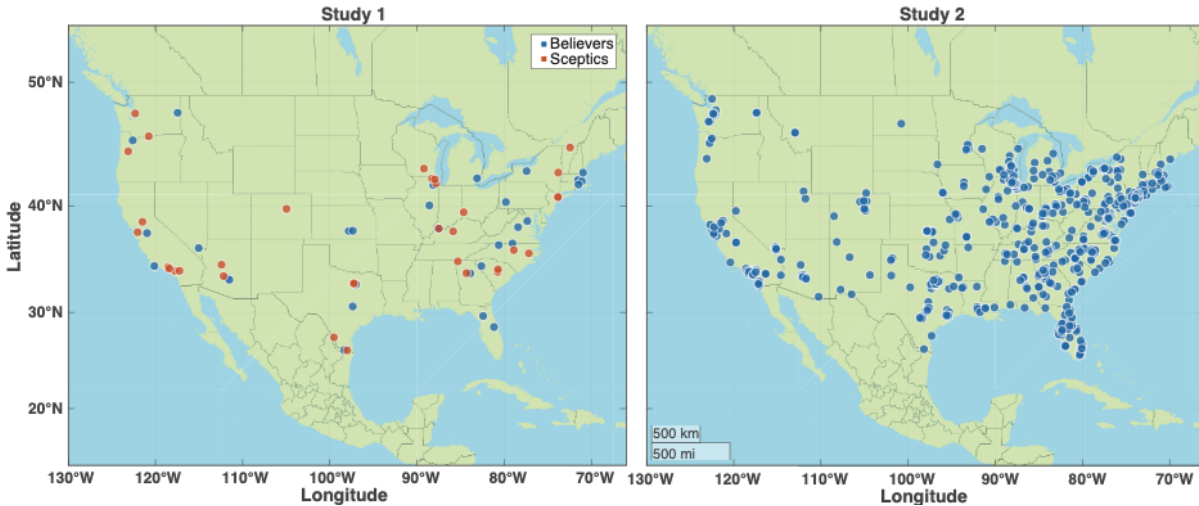


Figure S11. Participants geographical locations. Participants locations distribution in Study 1 (top) and Study 2 (bottom). Participants' allocation was similar across the states. States ranking (based on climate change policies, ranked from A-F, with F being aligned with sceptic policies; see <https://www.c2es.org/content/state-climate-policy/>) were equally represented in our samples. Our Study 2 participants breakdown aligns with a national Pew research done with a representative sample on July 14, 2022, and published the day our study initiated (see http://pewresearch.org/science/wp-content/uploads/sites/16/2022/07/ps_2022.07.14_climate-change-policies_topline.pdf).

Study 1

Descriptive information

| Variable | Control | Treatment |
|--------------------|-------------|-------------|
| Sample size | 73 | 70 |
| Age | 36.33 years | 35.61 years |
| Gender | 53% female | 48% female |
| Education | 3.91 | 3.80 |
| Income | 3.80 | 3.60 |
| Political ideology | 4.32 | 4.20 |
| Number of children | 0.88 | 0.79 |

Table T5. Demographics of Study 1 participants. For climate concerns breakdown, see **figure SI4**. The group assignment was done by self-proclaimed stated belief that climate change is true. Education was measured on a 6-point ordinal scale with the mean value of 4 representing the level of an associate or technical degree. Income was assessed in 10 brackets with the average value of 5 representing an income level of \$35-50k before tax. Political ideology was measured on a 1 (Very liberal) to 7 (very conservative).

Below we provide visualizations of Study 1 data.

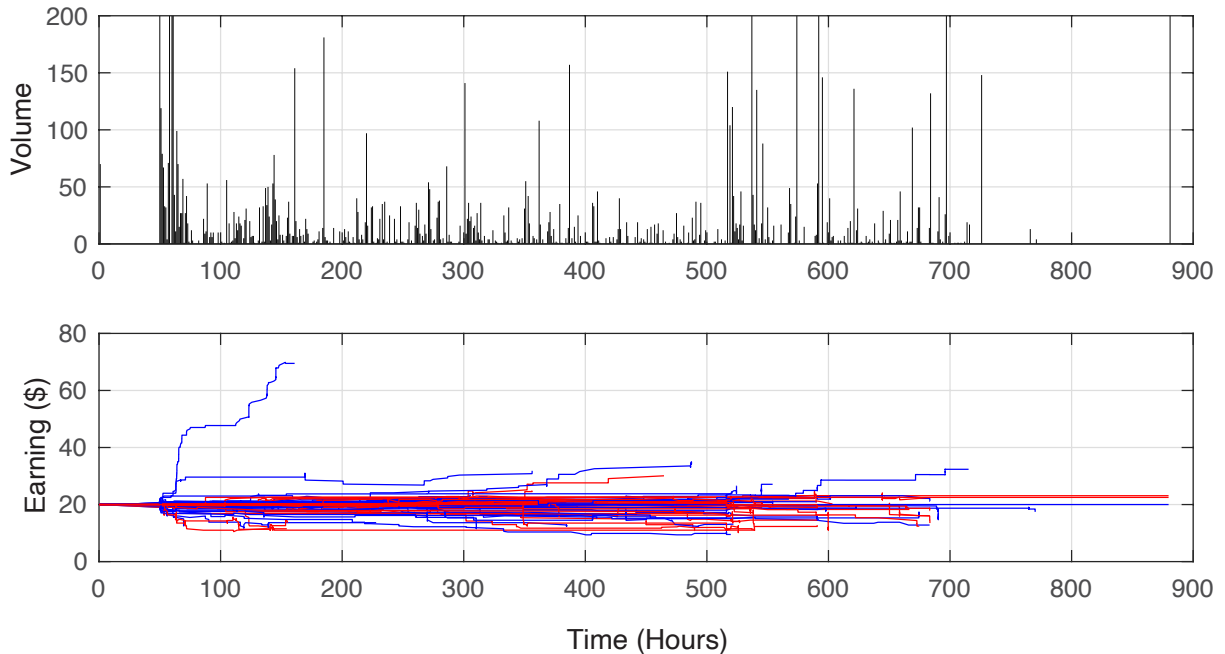


Figure SI2. Prediction market betting characteristics. Top: Investments volume by hour. The hourly number of bet offers that occurred in the market over 37 days (900 hours). Bottom: Amount of money earned by believers (blue) and sceptics (red) over the course of the prediction market timeline. Each line corresponds to a single participant. See **figure 1** for the cumulative earnings/loses by all believers (blue) and sceptics (red) throughout the month.

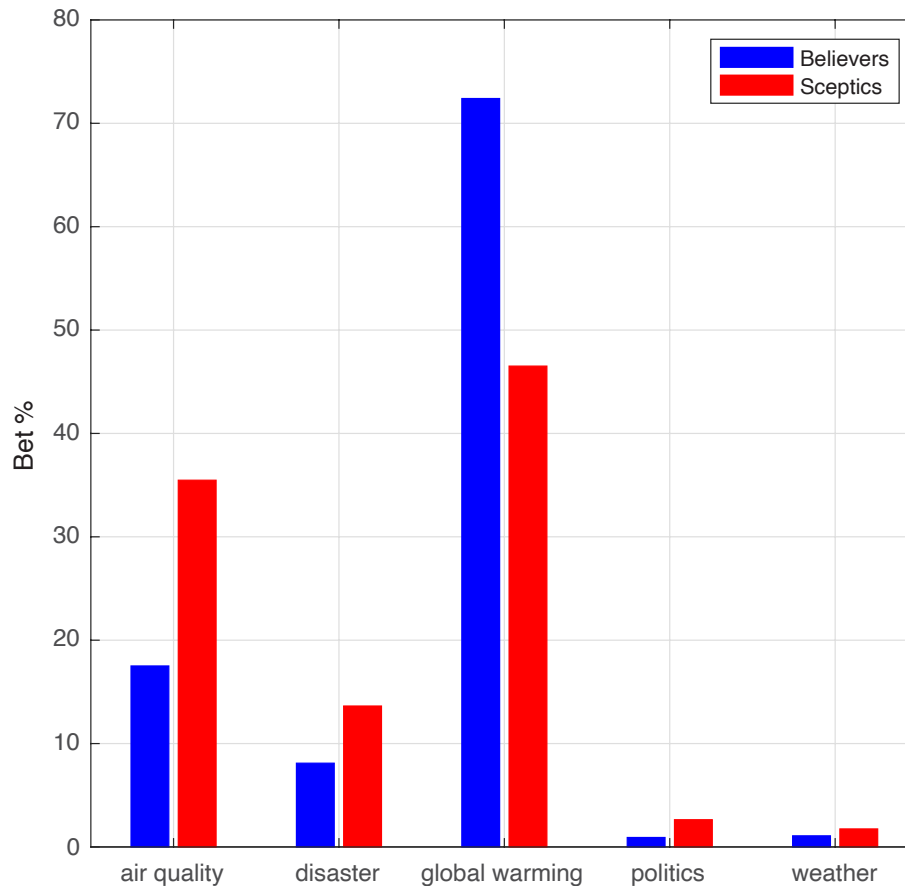


Figure SI3. Bet investment topics. Proportion of bet offers by believers (blue) and sceptics (red), divided by bet category.

Markets classification

We classified each market in studies 1 and 2 according to whether it reflected a “climate” or “weather” bet. Climate markets typically address *long-term* and/or *global* events (i.e., will the Arctic Sea Ice extent fall below 6.410 millions of kilometers² in the next decade) whereas “weather” markets reflect *short-term/local* events (i.e., will it rain tomorrow). Accordingly, we assigned to each market the properties “long-term”/“short-term” and “global”/“local”. *Long-term* assignment corresponded to markets that: 1) spanned weeks to years, or 2) compared current events to averages over large historical data (i.e., comparing the average global temperatures in August 2022 to all historical August averages on record). *Short-term* assignment corresponded to markets that spanned a time window of days (i.e., precipitation in the coming 24 hours). *Global* assignment corresponded to markets that spanned a wide geographical region of multiple locations around the globe (i.e., average Air Quality Index in the Northern Hemisphere). *Local* assignment corresponded to markets that focused on a single location (i.e., number of thunderstorms in New Orleans).

Using this classification, 63.6% of the of the markets were considered “climate” ones. Of those, 57.2% were long-term and 64.2% were global.

Differences in initial climate concerns between believers and sceptics

Confirming participants' self-assignment into climate believers and sceptics via the Pre-survey, independent t-tests showed that believers were significantly more likely to state that they believed climate change is happening (believers: 6.61 ± 0.64 out of a maximum of 7.00; mean \pm standard-deviation, std.; sceptics: 3.64 ± 1.58 , $t(141) = -14.80$, $p < 0.001$), that it is anthropogenic (believers: 6.13 ± 1.13 , sceptics: 2.60 ± 1.50 , $t(141) = -15.94$, $p < 0.001$) and that it poses a risk to humanity (believers: 6.26 ± 1.03 , sceptics: 2.62 ± 1.51 , $t(141) = -16.93$, $p < 0.001$; **Fig. SI4**). Given that the three measures were highly correlated (Cronbach's alpha across Pre- and Post-survey: 0.93) we subsequently analyzed the average of these three answers as a more robust way of capturing climate concerns. Sceptics showed a higher variance in concerns (mean std.: 1.53) compared to believers (mean std.: 0.93), suggesting that believers are more homogeneous in their beliefs than sceptics. Put differently, whereas believers are strongly convinced of their views, sceptics are not necessarily climate *deniers* (i.e., believers of an opposite opinion) but rather ambivalent/uncertain about climate science. However, given that individuals self-identified in the Pre-survey as believers or sceptics and the fact that the distribution of the aggregate ‘‘Concern about Climate Change’’ variable is bi-modal (**Fig. SI4**), our analyses retain this dichotomous group categorization. The results do not change when using climate belief as a continuous variable.

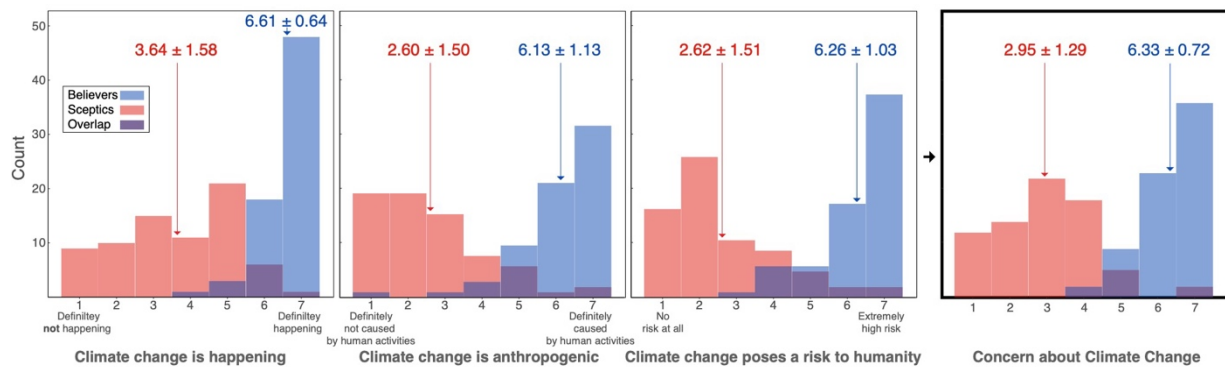


Figure SI4. Concerns about climate change. Distributions of climate concerns among believers (blue) and sceptics (red) in Study 1 *Pre*-survey. Vertical arrows depict the mean scores. The right panel shows the aggregate of the questions which was used in further analyses as the measure of climate change concern (higher numbers indicate stronger concern).

Differences in betting outcomes and behavior between believers and sceptics

Below is an illustration of the shift in outcomes and behavior between the Pre- and Post- surveys in Study 1.

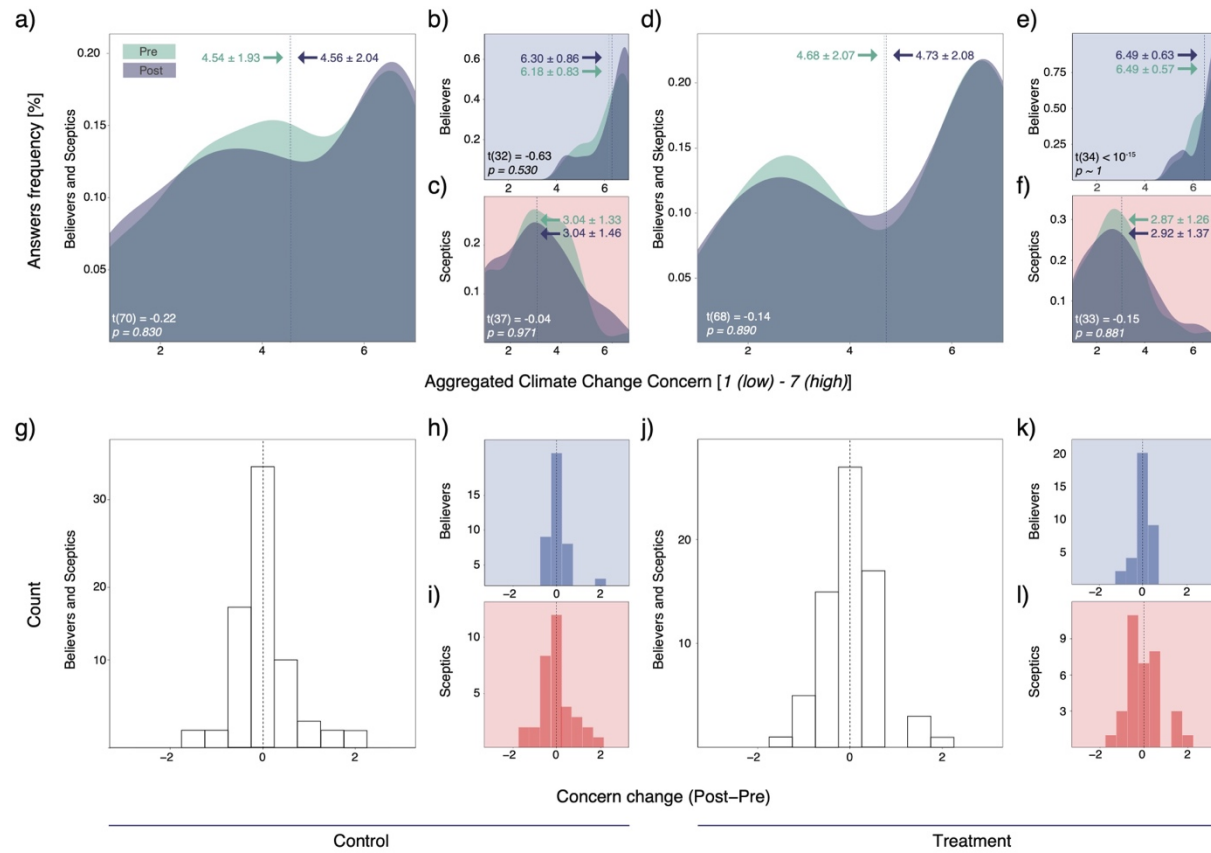


Fig. S15. Distributions of climate beliefs before and after participating in the climate market. Taking the average of the three survey questions pertaining to attitudes toward climate change (Fig. S14) we see that among Controls (a) there is no significant change in attitudes following a month of waiting (green: Pre-survey; blue: Post-survey). This is true when broken down by believers (b) and sceptics (c). Similarly, the treatment group (d) does not show significant change in attitudes following a month of engagement with a prediction market, as well as the subgroups: believers (e) and sceptics (f). Panels (g-l) correspond to the same data as (a-f) when analyzed as the difference between the distributions, showing that while there is generally little shift in attitudes, there are at least some people who change their attitudes in different directions. All t-tests are two-tailed.

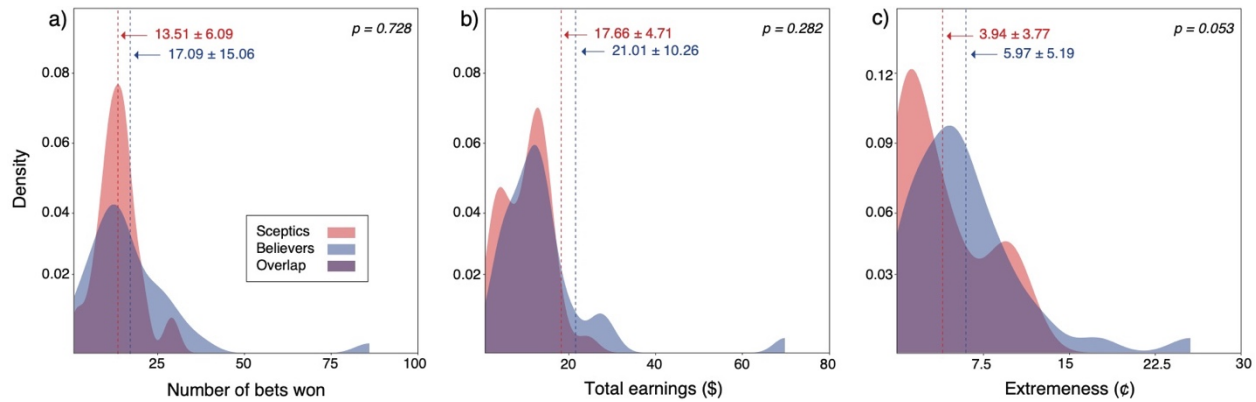


Figure SI6. Distribution of prediction market betting characteristics. Among believers (blue) and sceptics (red) who participated in the prediction market, betting outcomes (a-b) show no significant difference (p value on the top-right of each panel). Dashed lines mark the mean \pm standard-error. However, betting behavior (c) does show significant difference between the believers/sceptics, with believers taking more extreme (/confident) positions in their bets. The x-axis is the difference from a 50¢/50¢ position (e.g., a value of 30¢ suggests that the participant took a position with 80¢ when entering the contract).

Analysis of climate beliefs as continuous variable

Participants self-assigned discrete beliefs in climate change (believers or sceptics) were used for all the analyses in our work. The bi-modal nature of those beliefs was verified by our questionnaire (Fig. SI4). However, since discretizing the beliefs to two types may mask some nuanced results, we also analyzed belief as a continuous variable ranging from 1 (scepticism about climate change) to 7 (Belief in climate change). This continuous climate belief variable was calculated by averaging the Pre-survey responses to the three climate attitude questions. The results are consistent with those reported for the discrete self-reported climate belief variable.

In line with the findings reported in the main manuscript (Section “Winning bets in the market increases concern about global warming”), we did not find a significant interaction effect between betting outcomes and climate beliefs on attitude change, suggesting that betting outcomes predicted attitude change independent of climate beliefs (Number of bets won: $B=0.002$, $SE(B)=0.002$, $t=0.94$, $p=0.350$; Total earnings: $B=-0.006$, $SE(B)=0.009$, $t=-0.72$, $p=0.471$). Similar to before, there was also no significant interaction of continuous climate beliefs and betting behavior on attitude change (Confidence: $B=0.025$, $SE(B)=0.020$, $t=1.21$, $p=0.228$).

Aligned with the findings reported in the main manuscript (Section “Differences in betting outcomes and behavior between believers and sceptics”), we did not observe a significant effect of continuous climate beliefs on betting outcomes (Number of bets won: $B=0.26$, $SE(B)=0.45$, $t=0.57$, $p=0.568$; Total earnings: $B=0.08$, $SE(B)=0.26$, $t=0.32$, $p=0.748$). However, like for the discrete climate belief variable, a stronger belief in global warming was related to higher levels of confidence in ones’ bets ($B=0.14$, $SE(B)=0.06$, $t=2.41$, $p=0.019$).

No evidence for earnings via financial manipulation

One way by which participants could earn more money in the market without actually reflecting their beliefs is using financial manipulations. Financial manipulations are frequent in stock markets (i.e., arbitrage that stems from high frequency trading). A sceptic, for example, could earn income in the prediction market simply by understanding the nature of the market and utilizing it as a benefit. Two possible ways to do that would be: 1) placing offers that are relatively safe (50¢) as soon as a new bet appears, and then selling those quickly for a smaller income to the other participants, or 2) placing bets on opposing opinions and selling one when the market stabilizes (this would allow a participant to quickly use all their allotted \$20 without taking a large financial risk). To test whether this is the case we looked at the time between the bet publication and the first offer. No participant exhibited such behavior. No participant has had more than 11 offers on a single bet, suggesting that none have used financial tactics to earn money.

Additional survey analyses

Participant's demographic characteristics and risk tolerance were not significantly different between believers and sceptics. However, believers and sceptics slightly differed from one another with regard to general climate related knowledge questions (believers: 56% correct, sceptics: 50% correct, $t(141)=3.43$, $p<0.001$). While this suggests that believers have a more accurate reading of scientific facts and might therefore be more likely to financially benefit from a prediction market, the effect is small (a difference of about three questions out of 60).

Believers and sceptics differed significantly in their political orientation which aligned with traditional affiliations in the U.S. The majority of climate believers reported being more liberal (2.91 ± 1.40 on a 7-point scale, with 1 being Liberal and 7 Conservative) compared to sceptics (5.60 ± 1.31 ; $t(141)=11.86$, $p<0.001$).

Study 2

Descriptive information

| Variable | Control | Treatment | Chi-Square/T-test |
|--------------------|----------------|----------------|---------------------------|
| Sample size | 308 (64% full) | 356 (68% full) | $\chi^2(2)=1.71, p=0.191$ |
| Age | 42.21 years | 43.03 years | $t(651)=0.74, p=0.460$ |
| Gender | 49% female | 47% female | $\chi^2(2)=2.55, p=0.278$ |
| Education | 4.12±1.40 | 4.22±1.36 | $t(643)=0.92, p=0.359$ |
| Income | 4.97±2.38 | 5.01±2.45 | $t(654)=0.21, p=0.831$ |
| Political ideology | 4.41±1.62 | 4.52±1.60 | $t(647)=0.63, p=0.528$ |
| Number of children | 1.06±1.28 | 1.17±1.42 | $t(661)=1.07, p=0.284$ |
| Climate concern | 5.05±1.40 | 5.08±1.39 | $t(647)=0.03, p=0.978$ |
| Climate support | 4.29±1.28 | 4.27±1.32 | $t(653)=0.19, p=0.85$ |
| Climate knowledge | 5.60±1.54 | 5.43±1.49 | $t(642)=1.45, p=0.147$ |

Table T6. Study 2 participants randomization comparison. T-test and Chi-square statistics highlight the equivalence in samples achieved by the random assignment. Education was measured on a 6-point ordinal scale with the mean value of 4 representing the level of an associate or technical degree. Income was assessed in 10 brackets with the average value of 5 representing an income level of \$35-50k before tax. Political ideology was measured on a 1 (Very liberal) to 7 (very conservative). Climate concern, climate support and climate knowledge were measured on a 1-7 scale (see [table T4](#)).

In Study 2 we also inquired about participants' knowledge base and common sources of information. [Figure SI7](#) shows a breakdown of participants regular sources of climate information.

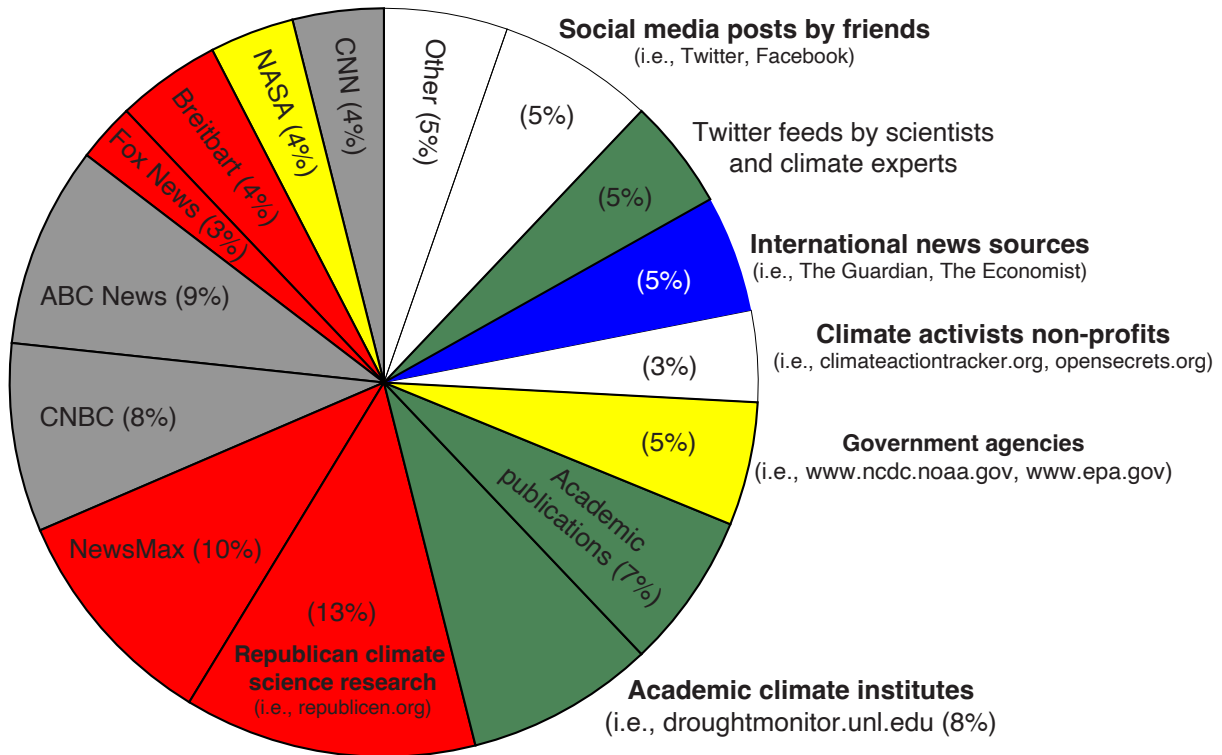


Figure SI7. Distribution of sources participants in the climate conditions reported using to make their bets. Colors depict qualitative breakdown by political/group affiliation.

Markets classification

Using the classification of markets to “Climate”/“Weather”, “Long-term”/“Short-term”, and “Global”/“Local” we note that 71.4% of the markets were classified as “climate”. Of those, 28% were long-term and 58.3% were global.

Of the 35 climate markets, 22 settled in line with the traditional climate science views (i.e., increased temperatures, water-level rise, etc.). We attempted to generate the market language such that a “Yes” prediction would align with climate science expectations (**Fig. 1b**). This was the case for all markets outside of market #17.

Analyses with complete model

Below we present the full model output of the analyses for the climate concern, support and knowledge in Study 2 (**tables T7-T9**).

| Predictor | Concern (Post-Survey) | | | |
|-----------------------|-----------------------|-------------------------|---------|------------------|
| | <i>B</i> | <i>CI</i> ₉₅ | β | <i>p</i> |
| <i>Intercept</i> | 0.54 | 0.12 — 0.95 | -0.07 | 0.011 |
| Condition [Treatment] | 0.12 | 0.03 — 0.21 | 0.08 | 0.007 |
| Concern in Pre-Survey | 0.93 | 0.89 — 0.97 | 0.88 | <0.001 |

| | | | | |
|--------------------|-------|---------------|-------|--------------|
| Gender [Female] | -0.04 | -0.13 — 0.05 | -0.01 | 0.379 |
| Age | 0.00 | -0.00 — 0.00 | 0.00 | 0.920 |
| Education | 0.00 | -0.03 — 0.04 | 0.00 | 0.850 |
| Race [1,2] | 0.11 | -0.40 — 0.62 | 0.08 | 0.664 |
| Race [1,3] | -0.11 | -0.58 — 0.36 | -0.07 | 0.644 |
| Race [1,3,5] | 0.28 | -0.85 — 1.41 | 0.19 | 0.630 |
| Race [1,4] | -0.42 | -0.99 — 0.15 | -0.29 | 0.148 |
| Race [1,6] | 0.28 | -0.28 — 0.85 | 0.19 | 0.329 |
| Race [2] | 0.06 | -0.09 — 0.21 | 0.04 | 0.431 |
| Race [2,3] | 0.08 | -1.06 — 1.21 | 0.05 | 0.896 |
| Race [2,4] | 0.01 | -1.13 — 1.14 | 0.00 | 0.990 |
| Race [3] | 0.39 | -0.12 — 0.89 | 0.26 | 0.134 |
| Race [4] | -0.12 | -0.30 — 0.07 | -0.08 | 0.224 |
| Race [6] | -0.10 | -0.56 — 0.37 | -0.07 | 0.678 |
| Employment [2] | 0.15 | 0.01 — 0.30 | 0.10 | 0.043 |
| Employment [3] | -0.04 | -0.20 — 0.12 | -0.03 | 0.643 |
| Employment [4] | -0.01 | -0.18 — 0.16 | -0.01 | 0.906 |
| Employment [5] | 0.20 | -0.06 — 0.46 | 0.14 | 0.130 |
| Employment [7] | 0.25 | 0.06 — 0.43 | 0.17 | 0.010 |
| Employment [9] | 0.11 | -0.19 — 0.40 | 0.07 | 0.474 |
| Number of children | -0.04 | -0.08 — -0.00 | -0.04 | 0.040 |
| Income | 0.02 | -0.00 — 0.05 | 0.03 | 0.106 |
| Religiosity | -0.01 | -0.03 — 0.02 | -0.01 | 0.534 |
| Political Ideology | -0.06 | -0.09 — -0.02 | -0.06 | 0.001 |
| Observations | 664 | | | |

R² / R² adjusted

0.855 / 0.850

Table T7. Linear regression analyses predicting climate concern in the Post-survey, controlling for concern in the Pre-survey. The category labels for race are: 1=White or Caucasian, 2=Black or African American, 3=American Indian/Native American or Alaska Native, 4=Asian, 5=Native Hawaiian or Other Pacific Islander, 6=Other. The category labels for employment are: 1=Employed (Full-time; reference), 2=Employed (Part-time), 3=Self-employed, 4=Unemployed, 5=Retired, 6=Student, 7=Other. Bold indicate significant values below 0.05.

| Predictor | Support (Post-Survey) | | | |
|-----------------------|-----------------------|-------------------------|----------|------------------|
| | <i>B</i> | <i>CI</i> ₉₅ | <i>β</i> | <i>p</i> |
| <i>Intercept</i> | 0.88 | 0.39 — 1.37 | -0.10 | <0.001 |
| Condition [Treatment] | 0.13 | 0.01 — 0.24 | 0.09 | 0.029 |
| Support in Pre-Survey | 0.83 | 0.78 — 0.88 | 0.82 | <0.001 |
| Gender [Female] | 0.05 | -0.06 — 0.17 | 0.02 | 0.376 |
| Age | 0.00 | -0.00 — 0.01 | 0.02 | 0.486 |
| Education | -0.02 | -0.07 — 0.03 | -0.02 | 0.364 |
| Race [1,2] | 0.51 | -0.15 — 1.16 | 0.34 | 0.130 |
| Race [1,3] | 0.05 | -0.55 — 0.65 | 0.03 | 0.877 |
| Race [1,3,5] | -0.19 | -1.64 — 1.27 | -0.13 | 0.801 |
| Race [1,4] | -0.02 | -0.75 — 0.71 | -0.02 | 0.951 |
| Race [1,6] | 0.06 | -0.67 — 0.78 | 0.04 | 0.880 |
| Race [2] | 0.12 | -0.07 — 0.31 | 0.08 | 0.231 |
| Race [2,3] | -0.22 | -1.68 — 1.23 | -0.15 | 0.766 |
| Race [2,4] | 0.54 | -0.92 — 2.00 | 0.36 | 0.466 |
| Race [3] | -0.26 | -0.92 — 0.39 | -0.18 | 0.425 |
| Race [4] | -0.01 | -0.25 — 0.23 | -0.00 | 0.966 |
| Race [6] | 0.14 | -0.46 — 0.74 | 0.10 | 0.638 |
| Employment [2] | 0.20 | 0.01 — 0.39 | 0.13 | 0.042 |
| Employment [3] | 0.06 | -0.14 — 0.27 | 0.04 | 0.542 |

| | | | | |
|--|---------------|---------------|-------|------------------|
| Employment [4] | 0.08 | -0.13 — 0.29 | 0.05 | 0.463 |
| Employment [5] | -0.09 | -0.42 — 0.25 | -0.06 | 0.612 |
| Employment [7] | 0.27 | 0.03 — 0.51 | 0.18 | 0.026 |
| Employment [9] | 0.05 | -0.33 — 0.43 | 0.03 | 0.788 |
| Number of children | -0.03 | -0.08 — 0.02 | -0.03 | 0.246 |
| Income | 0.02 | -0.02 — 0.05 | 0.03 | 0.321 |
| Religiosity | 0.01 | -0.02 — 0.04 | 0.02 | 0.424 |
| Political Ideology | -0.09 | -0.13 — -0.04 | -0.10 | <0.001 |
| Observations | 664 | | | |
| R ² / R ² adjusted | 0.765 / 0.756 | | | |

Table T8. Linear regression analyses predicting climate support in the Post-survey, controlling for support in the Pre-survey The category labels for race are: 1=White or Caucasian, 2=Black or African American, 3=American Indian/Native American or Alaska Native, 4=Asian, 5=Native Hawaiian or Other Pacific Islander, 6=Other. The category labels for employment are: 1=Employed (Full-time; reference), 2=Employed (Part-time), 3=Self-employed, 4=Unemployed, 5=Retired, 6=Student, 7=Other. Bold indicate significant values below 0.05.

| Predictor | Knowledge (Post-Survey) | | | |
|-------------------------|-------------------------|------------------------|----------|------------------|
| | <i>B</i> | <i>CI₉₅</i> | <i>β</i> | <i>p</i> |
| <i>Intercept</i> | 6.39 | 4.67 — 8.12 | -0.24 | <0.001 |
| Condition [Treatment] | 1.58 | 1.15 — 2.02 | 0.52 | <0.001 |
| Knowledge in Pre-Survey | 0.37 | 0.22 — 0.52 | 0.19 | <0.001 |
| Gender [Female] | -0.51 | -0.97 — -0.06 | -0.09 | 0.026 |
| Age | 0.03 | 0.01 — 0.05 | 0.15 | 0.002 |
| Education | 0.14 | -0.04 — 0.32 | 0.06 | 0.125 |
| Race [1,2] | -0.58 | -3.10 — 1.95 | -0.19 | 0.654 |
| Race [1,3] | -0.45 | -2.74 — 1.84 | -0.15 | 0.702 |
| Race [1,3,5] | -0.83 | -6.40 — 4.74 | -0.27 | 0.770 |
| Race [1,4] | 0.35 | -2.45 — 3.15 | 0.12 | 0.805 |

| | | | | |
|--|---------------|---------------|-------|--------------|
| Race [1,6] | -1.63 | -4.43 — 1.16 | -0.54 | 0.252 |
| Race [2] | -1.10 | -1.83 — -0.37 | -0.36 | 0.003 |
| Race [2,3] | -4.11 | -9.68 — 1.46 | -1.36 | 0.148 |
| Race [2,4] | 0.25 | -5.33 — 5.83 | 0.08 | 0.930 |
| Race [3] | -1.82 | -4.32 — 0.67 | -0.60 | 0.151 |
| Race [4] | -0.61 | -1.53 — 0.31 | -0.20 | 0.195 |
| Race [6] | -2.11 | -4.41 — 0.18 | -0.70 | 0.071 |
| Employment [2] | -0.18 | -0.91 — 0.56 | -0.06 | 0.641 |
| Employment [3] | 0.47 | -0.30 — 1.25 | 0.16 | 0.230 |
| Employment [4] | 0.35 | -0.47 — 1.17 | 0.12 | 0.405 |
| Employment [5] | 0.72 | -0.56 — 2.00 | 0.24 | 0.269 |
| Employment [7] | -0.16 | -1.08 — 0.76 | -0.05 | 0.728 |
| Employment [9] | 0.22 | -1.23 — 1.67 | 0.07 | 0.768 |
| Number of children | -0.05 | -0.24 — 0.13 | -0.02 | 0.568 |
| Income | 0.02 | -0.11 — 0.14 | 0.01 | 0.809 |
| Religiosity | -0.10 | -0.22 — 0.01 | -0.07 | 0.077 |
| Political Ideology | -0.16 | -0.31 — -0.00 | -0.08 | 0.044 |
| Observations | 664 | | | |
| R ² / R ² adjusted | 0.170 / 0.137 | | | |

Table T9. Linear regression analyses predicting climate knowledge in the Post-survey, controlling for knowledge in the Pre-survey The category labels for race are: 1=White or Caucasian, 2=Black or African American, 3=American Indian/Native American or Alaska Native, 4=Asian, 5=Native Hawaiian or Other Pacific Islander, 6=Other. The category labels for employment are: 1=Employed (Full-time; reference), 2=Employed (Part-time), 3=Self-employed, 4=Unemployed, 5=Retired, 6=Student, 7=Other. Bold indicate significant values below 0.05.

Robustness checks

To test whether the results hold across various conditions, we performed a variety of robustness check controlling for numerous variables. See **tables T10-T17** below.

| Predictor | Concern (Post-Survey), No controls | | | |
|--|------------------------------------|-------------------------|---------|------------------|
| | <i>B</i> | <i>CI</i> ₉₅ | β | <i>p</i> |
| <i>Intercept</i> | 0.13 | -0.04 — 0.31 | -0.04 | 0.142 |
| Condition [Treatment] | 0.10 | 0.01 — 0.19 | 0.07 | 0.023 |
| Concern in Pre-Survey | 0.97 | 0.94 — 1.00 | 0.92 | <0.001 |
| Observations | 664 | | | |
| R ² / R ² adjusted | 0.845 / 0.845 | | | |

Table T10. Linear regression analyses predicting climate concern in the Post-survey, controlling for concern in the Pre-survey. Bold indicate significant values below 0.05.

| Predictor | Concern (Post-Survey), sub-sampling for seriousness (> 9) | | | |
|-----------------------|---|-------------------------|---------|------------------|
| | <i>B</i> | <i>CI</i> ₉₅ | β | <i>p</i> |
| <i>Intercept</i> | 0.51 | 0.02 — 1.00 | -0.09 | 0.042 |
| Condition [Treatment] | 0.16 | 0.05 — 0.26 | 0.11 | 0.003 |
| Concern in Pre-Survey | 0.92 | 0.88 — 0.97 | 0.88 | <0.001 |
| Gender [Female] | -0.05 | -0.16 — 0.05 | -0.02 | 0.327 |
| Age | -0.00 | -0.00 — 0.00 | -0.00 | 0.964 |
| Education | -0.00 | -0.04 — 0.04 | -0.00 | 0.981 |
| Race [1,2] | 0.09 | -0.52 — 0.69 | 0.06 | 0.782 |
| Race [1,3] | -0.13 | -0.66 — 0.41 | -0.08 | 0.645 |
| Race [1,4] | -0.27 | -1.45 — 0.91 | -0.18 | 0.650 |
| Race [1,6] | 0.30 | -0.29 — 0.89 | 0.20 | 0.323 |
| Race [2] | 0.12 | -0.06 — 0.30 | 0.08 | 0.201 |
| Race [2,4] | -0.04 | -1.23 — 1.15 | -0.03 | 0.951 |
| Race [3] | 0.34 | -0.26 — 0.94 | 0.23 | 0.266 |

| | | | | |
|--|---------------|---------------|-------|--------------|
| Race [4] | -0.18 | -0.40 — 0.05 | -0.12 | 0.128 |
| Race [6] | -0.05 | -0.65 — 0.56 | -0.03 | 0.884 |
| Employment [2] | 0.18 | 0.01 — 0.36 | 0.12 | 0.043 |
| Employment [3] | -0.06 | -0.25 — 0.12 | -0.04 | 0.497 |
| Employment [4] | -0.01 | -0.22 — 0.20 | -0.01 | 0.928 |
| Employment [5] | 0.30 | -0.06 — 0.66 | 0.20 | 0.097 |
| Employment [6] | 0.21 | -0.01 — 0.43 | 0.14 | 0.058 |
| Employment [7] | 0.15 | -0.24 — 0.55 | 0.10 | 0.445 |
| Number of children | -0.03 | -0.07 — 0.01 | -0.03 | 0.151 |
| Income | 0.03 | -0.00 — 0.06 | 0.04 | 0.074 |
| Religiosity | -0.01 | -0.04 — 0.02 | -0.02 | 0.436 |
| Political Ideology | -0.05 | -0.09 — -0.00 | -0.05 | 0.031 |
| Observations | 518 | | | |
| R ² / R ² adjusted | 0.848 / 0.840 | | | |

Table T11. Linear regression analyses predicting climate concern in the Post-survey using solely the data from the participants who stated that they took the study very seriously. The category labels for race are: 1=White or Caucasian, 2=Black or African American, 3=American Indian/Native American or Alaska Native, 4=Asian, 5=Native Hawaiian or Other Pacific Islander, 6=Other. The category labels for employment are: 1=Employed (Full-time; reference), 2=Employed (Part-time), 3=Self-employed, 4=Unemployed, 5=Retired, 6=Student, 7=Other. Bold indicate significant values below 0.05.

| Predictor | Concern (Post-Survey), Δ Concern | | | |
|-----------------------|---|-------------------------|---------|--------------|
| | <i>B</i> | <i>CI</i> ₉₅ | β | <i>p</i> |
| <i>Intercept</i> | 0.01 | -0.29 — 0.31 | -0.19 | 0.970 |
| Condition [Treatment] | 0.12 | 0.03 — 0.21 | 0.20 | 0.010 |
| Gender [Female] | -0.04 | -0.14 — 0.05 | -0.04 | 0.363 |
| Age | 0.00 | -0.00 — 0.01 | 0.03 | 0.532 |
| Education | 0.00 | -0.03 — 0.04 | 0.01 | 0.871 |

| | | | | |
|--|---------------|---------------|-------|--------------|
| Race [1,2] | 0.13 | -0.38 — 0.65 | 0.23 | 0.608 |
| Race [1,3] | -0.02 | -0.49 — 0.45 | -0.04 | 0.924 |
| Race [1,4] | -0.42 | -0.99 — 0.16 | -0.72 | 0.155 |
| Race [1,6] | 0.29 | -0.28 — 0.87 | 0.50 | 0.313 |
| Race [2] | 0.07 | -0.08 — 0.22 | 0.12 | 0.351 |
| Race [2,4] | 0.02 | -1.12 — 1.16 | 0.04 | 0.971 |
| Race [3] | 0.43 | -0.08 — 0.94 | 0.74 | 0.098 |
| Race [4] | -0.11 | -0.30 — 0.07 | -0.20 | 0.233 |
| Race [6] | -0.08 | -0.55 — 0.39 | -0.14 | 0.742 |
| Race [1,3,5] | 0.41 | -0.73 — 1.55 | 0.70 | 0.483 |
| Race [2,3] | 0.03 | -1.11 — 1.18 | 0.06 | 0.953 |
| Employment [2] | 0.14 | -0.01 — 0.29 | 0.24 | 0.068 |
| Employment [3] | -0.03 | -0.19 — 0.13 | -0.05 | 0.710 |
| Employment [4] | 0.01 | -0.16 — 0.18 | 0.02 | 0.911 |
| Employment [5] | 0.20 | -0.06 — 0.46 | 0.34 | 0.134 |
| Employment [6] | 0.25 | 0.06 — 0.44 | 0.43 | 0.009 |
| Employment [7] | 0.13 | -0.17 — 0.42 | 0.22 | 0.404 |
| Number of children | -0.04 | -0.08 — -0.00 | -0.09 | 0.035 |
| Income | 0.02 | -0.01 — 0.04 | 0.08 | 0.154 |
| Religiosity | -0.01 | -0.03 — 0.02 | -0.03 | 0.559 |
| Political Ideology | -0.03 | -0.06 — 0.00 | -0.07 | 0.095 |
| Observations | 664 | | | |
| R ² / R ² adjusted | 0.059 / 0.022 | | | |

Table T12. Linear regression analyses predicting the difference in climate concern between Pre- and Post-survey. The category labels for race are: 1=White or Caucasian, 2=Black or African American, 3=American Indian/Native American or Alaska Native, 4=Asian, 5=Native Hawaiian or Other Pacific Islander, 6=Other. The category labels for employment are: 1=Employed (Full-

time; reference), 2=Employed (Part-time), 3=Self-employed, 4=Unemployed, 5=Retired, 6=Student, 7=Other. Bold indicate significant values below 0.05.

| Predictor | Support (Post-Survey), No controls | | | |
|--|------------------------------------|-------------------------|---------|------------------|
| | <i>B</i> | <i>CI</i> ₉₅ | β | <i>p</i> |
| <i>Intercept</i> | 0.58 | 0.39 — 0.76 | -0.04 | <0.001 |
| Condition [Treatment] | 0.11 | -0.01 — 0.22 | 0.07 | 0.063 |
| Support in Pre-Survey | 0.87 | 0.83 — 0.91 | 0.87 | <0.001 |
| Observations | 664 | | | |
| R ² / R ² adjusted | 0.752 / 0.751 | | | |

Table T13. Linear regression analyses predicting climate support in the Post-survey, controlling for support in the Pre-survey. Bold indicate significant values below 0.05.

| Predictor | Support (Post-Survey), sub-sampling for seriousness (> 9) | | | |
|-----------------------|---|-------------------------|---------|------------------|
| | <i>B</i> | <i>CI</i> ₉₅ | β | <i>p</i> |
| <i>Intercept</i> | 0.82 | 0.25 — 1.39 | -0.12 | 0.005 |
| Condition [Treatment] | 0.17 | 0.04 — 0.31 | 0.11 | 0.011 |
| Support in Pre-Survey | 0.82 | 0.77 — 0.88 | 0.83 | <0.001 |
| Gender [Female] | 0.08 | -0.06 — 0.21 | 0.03 | 0.288 |
| Age | 0.00 | -0.00 — 0.01 | 0.02 | 0.556 |
| Education | -0.03 | -0.08 — 0.03 | -0.02 | 0.355 |
| Race [1,2] | 0.67 | -0.10 — 1.44 | 0.44 | 0.088 |
| Race [1,3] | 0.13 | -0.55 — 0.82 | 0.09 | 0.701 |
| Race [1,4] | 1.16 | -0.34 — 2.66 | 0.77 | 0.128 |
| Race [1,6] | 0.08 | -0.67 — 0.84 | 0.05 | 0.831 |
| Race [2] | 0.15 | -0.08 — 0.38 | 0.10 | 0.193 |
| Race [2,4] | 0.57 | -0.94 — 2.08 | 0.38 | 0.460 |
| Race [3] | -0.12 | -0.88 — 0.64 | -0.08 | 0.756 |
| Race [4] | -0.06 | -0.35 — 0.23 | -0.04 | 0.698 |

| | | | | |
|--|---------------|---------------|-------|--------------|
| Race [6] | 0.28 | -0.49 — 1.05 | 0.19 | 0.473 |
| Employment [2] | 0.18 | -0.04 — 0.41 | 0.12 | 0.109 |
| Employment [3] | 0.12 | -0.12 — 0.35 | 0.08 | 0.325 |
| Employment [4] | 0.08 | -0.19 — 0.34 | 0.05 | 0.560 |
| Employment [5] | -0.24 | -0.69 — 0.22 | -0.16 | 0.304 |
| Employment [6] | 0.25 | -0.03 — 0.53 | 0.17 | 0.078 |
| Employment [7] | 0.31 | -0.19 — 0.81 | 0.21 | 0.218 |
| Number of children | -0.03 | -0.08 — 0.03 | -0.02 | 0.351 |
| Income | 0.02 | -0.02 — 0.06 | 0.03 | 0.286 |
| Religiosity | 0.01 | -0.02 — 0.05 | 0.02 | 0.463 |
| Political Ideology | -0.08 | -0.14 — -0.03 | -0.09 | 0.002 |
| Observations | 518 | | | |
| R ² / R ² adjusted | 0.760 / 0.748 | | | |

Table T14. Linear regression analyses predicting climate support in the Post-survey using solely the data from the participants who stated that they took the study very seriously. The category labels for race are: 1=White or Caucasian, 2=Black or African American, 3=American Indian/Native American or Alaska Native, 4=Asian, 5=Native Hawaiian or Other Pacific Islander, 6=Other. The category labels for employment are: 1=Employed (Full-time; reference), 2=Employed (Part-time), 3=Self-employed, 4=Unemployed, 5=Retired, 6=Student, 7=Other. Bold indicate significant values below 0.05.

| Predictor | Support (Post-Survey), Δ Support | | | |
|-----------------------|---|-------------------------|---------|--------------|
| | <i>B</i> | <i>CI</i> ₉₅ | β | <i>p</i> |
| <i>Intercept</i> | -0.24 | -0.64 — 0.15 | -0.22 | 0.226 |
| Condition [Treatment] | 0.12 | 0.00 — 0.24 | 0.16 | 0.043 |
| Gender [Female] | 0.04 | -0.08 — 0.16 | 0.03 | 0.532 |
| Age | 0.00 | -0.00 — 0.01 | 0.06 | 0.242 |
| Education | -0.02 | -0.07 — 0.02 | -0.04 | 0.321 |
| Race [1,2] | 0.56 | -0.12 — 1.24 | 0.73 | 0.107 |

| | | | | |
|--|---------------|--------------|-------|--------------|
| Race [1,3] | 0.25 | -0.37 — 0.87 | 0.33 | 0.424 |
| Race [1,4] | 0.05 | -0.71 — 0.81 | 0.06 | 0.901 |
| Race [1,6] | 0.11 | -0.65 — 0.87 | 0.14 | 0.774 |
| Race [2] | 0.17 | -0.03 — 0.36 | 0.22 | 0.100 |
| Race [2,4] | 0.55 | -0.96 — 2.07 | 0.72 | 0.474 |
| Race [3] | -0.14 | -0.82 — 0.53 | -0.19 | 0.679 |
| Race [4] | -0.02 | -0.27 — 0.23 | -0.02 | 0.895 |
| Race [6] | 0.26 | -0.36 — 0.88 | 0.34 | 0.412 |
| Race [1,3,5] | 0.06 | -1.45 — 1.57 | 0.08 | 0.939 |
| Race [2,3] | -0.17 | -1.68 — 1.34 | -0.22 | 0.824 |
| Employment [2] | 0.18 | -0.02 — 0.38 | 0.23 | 0.080 |
| Employment [3] | 0.10 | -0.11 — 0.31 | 0.13 | 0.355 |
| Employment [4] | 0.15 | -0.07 — 0.37 | 0.19 | 0.190 |
| Employment [5] | -0.06 | -0.41 — 0.29 | -0.08 | 0.738 |
| Employment [6] | 0.35 | 0.10 — 0.60 | 0.46 | 0.006 |
| Employment [7] | 0.13 | -0.26 — 0.53 | 0.17 | 0.509 |
| Number of children | -0.04 | -0.09 — 0.01 | -0.06 | 0.153 |
| Income | 0.01 | -0.02 — 0.05 | 0.04 | 0.443 |
| Religiosity | 0.01 | -0.02 — 0.04 | 0.02 | 0.608 |
| Political Ideology | -0.00 | -0.04 — 0.04 | -0.00 | 0.989 |
| Observations | 664 | | | |
| R ² / R ² adjusted | 0.046 / 0.009 | | | |

Table T15. Linear regression analyses predicting the difference in climate support between Pre- and Post-survey. The category labels for race are: 1=White or Caucasian, 2=Black or African American, 3=American Indian/Native American or Alaska Native, 4=Asian, 5=Native Hawaiian or Other Pacific Islander, 6=Other. The category labels for employment are: 1=Employed (Full-time; reference), 2=Employed (Part-time), 3=Self-employed, 4=Unemployed, 5=Retired, 6=Student, 7=Other. Bold indicate significant values below 0.05.

| Predictor | Knowledge (Post-Survey), No controls | | | |
|--|--------------------------------------|-------------------------|---------|----------------|
| | <i>B</i> | <i>CI</i> ₉₅ | β | <i>p</i> |
| <i>Intercept</i> | 6.33 | 5.46 — 7.20 | -0.29 | < 0.001 |
| Condition [Treatment] | 1.65 | 1.21 — 2.09 | 0.55 | < 0.001 |
| Knowledge [Pre-Survey] | 0.37 | 0.23 — 0.52 | 0.19 | < 0.001 |
| Observations | 664 | | | |
| R ² / R ² adjusted | 0.103 / 0.101 | | | |

Table T16. Linear regression analyses predicting climate knowledge in the Post-survey, controlling for knowledge in the Pre-survey. Bold indicate significant values below 0.05.

| Predictor | Knowledge (Post-Survey), Controlling for seriousness (> 9) | | | |
|-------------------------|--|-------------------------|---------|----------------|
| | <i>B</i> | <i>CI</i> ₉₅ | β | <i>p</i> |
| <i>Intercept</i> | 6.39 | 4.42 — 8.35 | -0.27 | < 0.001 |
| Condition [Treatment] | 1.79 | 1.30 — 2.28 | 0.59 | < 0.001 |
| Knowledge in Pre-Survey | 0.35 | 0.18 — 0.51 | 0.18 | < 0.001 |
| Gender [Female] | -0.43 | -0.95 — 0.09 | -0.07 | 0.103 |
| Age | 0.03 | 0.01 — 0.06 | 0.16 | 0.003 |
| Education | 0.05 | -0.15 — 0.26 | 0.02 | 0.606 |
| Race [1,2] | -0.72 | -3.56 — 2.13 | -0.24 | 0.622 |
| Race [1,3] | -0.13 | -2.63 — 2.38 | -0.04 | 0.921 |
| Race [1,4] | 1.63 | -3.90 — 7.17 | 0.54 | 0.563 |
| Race [1,6] | -1.71 | -4.51 — 1.09 | -0.57 | 0.230 |
| Race [2] | -1.18 | -2.03 — -0.33 | -0.39 | 0.006 |
| Race [2,4] | 0.10 | -5.49 — 5.68 | 0.03 | 0.972 |
| Race [3] | -1.46 | -4.26 — 1.33 | -0.48 | 0.304 |
| Race [4] | -1.13 | -2.19 — -0.06 | -0.37 | 0.039 |
| Race [6] | -1.38 | -4.22 — 1.46 | -0.46 | 0.340 |

| | | | | |
|--|---------------|---------------|-------|--------------|
| Employment [2] | -0.04 | -0.88 — 0.79 | -0.01 | 0.921 |
| Employment [3] | 0.27 | -0.59 — 1.14 | 0.09 | 0.535 |
| Employment [4] | 0.50 | -0.47 — 1.47 | 0.17 | 0.312 |
| Employment [5] | 0.58 | -1.10 — 2.26 | 0.19 | 0.497 |
| Employment [7] | -0.26 | -1.28 — 0.76 | -0.09 | 0.620 |
| Employment [9] | 0.30 | -1.54 — 2.14 | 0.10 | 0.749 |
| Number of children | -0.14 | -0.34 — 0.06 | -0.06 | 0.168 |
| Income | 0.10 | -0.04 — 0.24 | 0.08 | 0.153 |
| Religiosity | -0.08 | -0.21 — 0.05 | -0.05 | 0.246 |
| Political Ideology | -0.18 | -0.36 — -0.01 | -0.10 | 0.036 |
| Observations | 518 | | | |
| R ² / R ² adjusted | 0.183 / 0.143 | | | |

Table T17. Linear regression analyses predicting climate knowledge in the Post-survey using solely the data from the participants who stated that they took the study very seriously. The category labels for race are: 1=White or Caucasian, 2=Black or African American, 3=American Indian/Native American or Alaska Native, 4=Asian, 5=Native Hawaiian or Other Pacific Islander, 6=Other. The category labels for employment are: 1=Employed (Full-time; reference), 2=Employed (Part-time), 3=Self-employed, 4=Unemployed, 5=Retired, 6=Student, 7=Other. Bold indicate significant values below 0.05.

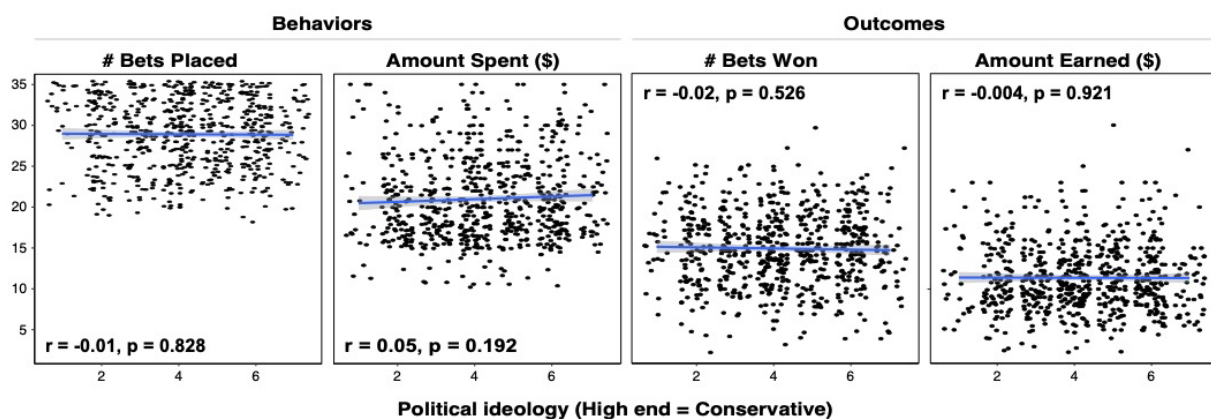


Figure SI8. Correlation between political ideology and betting behavior/outcomes. Across four different properties of the betting behavior (two left panels) and betting outcomes (two right panels) we see no correlation between political ideology and the evaluated metric. Blue line depicts the correlation with shaded confidence intervals. Black dots are the specific values for

each participant. Correlation coefficients and significance are on the bottom- and top-left corners.

Additional survey analyses

Participants in the climate prediction market condition reported in the Post-survey that they *very rarely* (2.12 ± 1.22 , on a scale of 1 [*Never*]—7 [*Very frequently*]) placed bets that conflicted with their personal beliefs.

Participants in the climate prediction market condition reported in the Post-survey that they *slightly* (2.10 ± 1.03 , on a scale of 1 [*Not at all*]—5 [*Changed extremely*]) changed their future betting strategy based on success/failure in the past predictions.

Participants who reported being more conservative primarily relied on traditionally right-leaning media sources for their climate data (namely, NewsMax, Republican research groups, Breitbart, and Fox News), whereas the remaining participants were divided equally across all other media sources (**Fig. S17**). Our findings suggest that individuals who participated in the prediction market did not consume significantly more news stories during the betting period.

Mid-study survey

Importantly, the outcomes in Study 2 hold despite the fact that the natural climate occurrence may have made the effects smaller given that the first ten days of our study only one had a single outcome that materialized in a way that signals the severity of climate change (which, participants who are not savvy with climate issues could interpret as an indication that betting consistent with the scientific consensus on global warming is a losing strategy). To address this organic control, we added another mid-study survey where we probed participants' climate concerns and support on day 16 of the betting market. Participants were encouraged to complete the survey but not mandated (653 out of 664 completed the survey). The findings show no negative backlash effect in the climate treatment condition. Although the treatment effect did not yet reach statistical significance for climate concern ($B=0.04$, $SE(B)=0.05$, $\beta=0.03$, $t=0.92$, $p=0.360$; including all controls), it was significant for climate support ($B=0.16$, $SE(B)=0.06$, $\beta=0.11$, $t=2.77$, $p=0.006$).

Future analyses

Our surveys included various items (i.e., bets on long-term future climate events that settled outside the timeline of our study) which could be further analyzed. For completion, we provide below the additional items collected (data available [online](#) for future analyses).

Additional measures, Study 1:

Demographics

Ethnicity, Employment, Marital status, [geo-location, IP, Operating System]

Politics

§ What political party do you identify with? [*Republican, Democratic, Independent, Green, Libertarian, Other*]

§ Who did you vote for in the last election? [*Hilary Clinton, Donald Trump, Did not vote, Voted for someone else*]

§ Rank the order by which they affect your choice of candidate (click and drag to order). [*Foreign policy, Immigration, Defense, Economy, Local state issues, Education, Religion (abortion, family values, etc.), Rights (gun control, etc.), Climate, Other*]

§ To what extent do you disagree or agree that: “If the government spent less time trying to fix everyone’s problems, we’d all be a lot

§ better off”? [1 (*Strongly disagree*) — 7 (*Strongly agree*)]

Religious beliefs (Note: Text in orange is shown if the participant clicks ‘Read More’)

§ Would you describe yourself as a religious person? [1 (*Not at all religious*) — 7 (*Very religious*)]

§ How strongly do you believe that your personal actions will affect the world globally? (as in, *change outcomes like the course of a country, war, etc.*) [1 (*Not at all*) — 7 (*Very*)]

§ What religion do you affiliate with mostly — of the following options: [*No religion (atheist of agnostic), Christian, Buddhist, Hindu, Jewish, Muslim, Sikh, Other*]

§ How many times have you attended an organized religious service in the past month?

§ Rate the extent to which the information taught throughout your education has aligned with or supported your belief? [0 (*no agreement*) — 10 (*total agreement*)]

§ Rate the extent to which college education has changed your religious beliefs. [0 (*no change at all*) — 10 (*totally changed*)]

§ Which of the following statements comes closest to your views on the origin and development of human beings [*Human beings have developed over millions of years from less advanced forms of life, but God guided this process, Human beings have developed over millions of years from less advanced forms of life, but God had no part in this process, God created human beings pretty much in their present form at one time within the last 10,000 years or so, Other/No opinion*]

Engagement

How many climate-related news stories or social media posts did you engage with (read or attend to in some other way) this past week?

Climate opinions

§ Should the government increase environmental regulations to prevent global warming?

Global warming, or climate change, is an increase in the earth's atmospheric temperature since the late nineteenth century. In politics the debate over global warming is centered on whether this increase in temperature is due to greenhouse gas emissions or is the result of a natural pattern in the earth's temperature.

[Yes; Yes, and provide more incentives for alternative energy production; No; No, tax carbon emission instead; No, global warming is a natural occurrence; No, provide more incentives for alternative energy production instead; Other]

§ Should national parks be preserved and protected by the federal government?

The U.S. currently has 59 areas of land in 27 different states that are designated as National Parks by the federal government. The National Park Service Organic Act was signed into law in 1916 "To conserve the scenery and the natural and historic objects and wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations".

[Yes; Yes, but allow more recreational access; Yes, and the government should protect more land; Yes, but allow limited logging, drilling and mining; No; No, the government currently owns too much land; Other]

§ Should producers be required to label genetically engineered foods (GMOs)?

Currently, GMO (Genetically Modified Organism) foods in the United States are not classified differently by the FDA and do not require labeling. Although no reports of ill effects from GMO foods have been documented, advocacy groups such as Greenpeace and the Organic Consumers Association argue that past studies cannot be trusted because they were sponsored by pro-GMO companies and do not measure the long-term effects on humans, the environment, and nature. Opponents argue that labeling adds an unfounded stigma over organic foods and that if a nutritional or allergenic difference were found, current FDA regulations would already require a label.

[Yes; Yes, but I would prefer to ban GMOs; Yes, consumers have a right to know what is in their food; Yes, I trust the science of responsible food engineering but I don't trust the motives of the food companies selling them; No; No, we have selectively bred crops for thousands of years and labeling just adds an unfounded stigma to the science; No, GMOs are the most promising solution to ending world hunger; No, producers should not be allowed to patent foods; Other]

§ Do you support the use of hydraulic fracking to extract oil and natural gas resources?

Fracking is the process of extracting oil or natural gas from shale rock. Water, sand and chemicals are injected into the rock at high pressure which fractures the rock and allows the oil or gas to flow out to a well. While fracking has significantly boosted oil production, there are environmental concerns that the process is contaminating groundwater.

[Yes; Yes, but increase oversight; Yes, but not in heavily populated areas; No; No, more research is needed to measure the long term effects of fracking; No, we should pursue more sustainable energy resources instead; Other]

§ Should the U.S. expand offshore oil drilling?

In 1990 President George H.W. Bush passed an executive order banning all offshore drilling in U.S. coastal waters. In response to rising gas prices in 2008 President George W. Bush lifted the ban. Currently, there are 3,500 offshore oil rigs, 79 of which are deep water wells.

[Yes; Yes, and deregulate the energy sector to let the free market determine the best energy ; No; No, end al offshore oil drilling; No, and nationalize the energy sector; No, but maintain our current offshore oil wells; No, and provide more incentives for alternative energy production sources; Other]

§ Should the government give tax credits and subsidies to the wind power industry?

As of July 2013, nearly 4% of all electricity generated in the U.S. is produced by wind turbines. By installing wind turbines on their property farmers can earn up to tens of thousands of dollars per year in tax credits. Since 2008 these tax credits have amounted to more than \$14 Billion.

[Yes; Yes, the government should support more sustainable energy technologies; Yes, wind power is the best alternative to coal and natural gas; No; No, end all tax credits and subsidies to the energy industry; No, and the government should never support unproven technologies; No, wind power is an inferior alternative to oil, coal, and nuclear power; Other]

Causes of climate change

For each of the following potential causes, rate the degree to which it has an effect on climate change [-2 (action strongly counteracts climate change — +2 (action strongly contributes to climate change)]

- § Recycling
- § Tiny Homes
- § Air conditioning
- § Nest thermostat
- § Plastic bags
- § BBQ-ing
- § Fireworks
- § Transportation
- § Electric cars
- § Agriculture
- § Cement production
- § Praying to god
- § Population increase
- § Flying
- § Driving gas powered cars
- § Bitcoin mining
- § Skiing
- § Buying oranges
- § Listening to NPR
- § Buying local products
- § Being a vegetarian
- § Al Gore
- § Cows Methane
- § Increase in bottled-water drinking

- § Population increase
- § Deforestation
- § Fracking
- § Oil drilling

Table T18. Pre-/Post-surveys items in Study 1 which were not analyzed. Text in blue marks the question. Text in black depicts the potential answers in multiple-choice items. Bold text corresponds to the correct answer in knowledge questions. Text in orange indicates that participants could select to “read more...”.

Additional measures, Study 2:

Demographics

Ethnicity, Employment, Marital status, [geo-location, IP, Operating System]

Politics

§ What political party do you identify with? [*Republican, Democratic, Independent, Green, Libertarian, Other*]

Religious beliefs

§ Would you describe yourself as a religious person? [1 (*Not at all religious*) — 7 (*Very religious*)]

Engagement

§ How engaged are you in reading/learning/talking/etc. about climate issues currently? (i.e., compared to your friends, colleagues, peers) [1 (*Strongly disagree*) — 7 (*Strongly agree*)]

Climate knowledge, not bets-related (Questions appearing only in *Post-survey*) [**Bold text marks correct answer**]

1. What is the technical term for a narrow corridor of concentrated moisture in the atmosphere? [*Atmospheric band, **Atmospheric River**, Tropical cloud, Tropical atmosphere*]
2. What is a La Niña? [*Events that lead to wetter, snowier conditions in the winter, Events that lead to forming shorter daylight, The above-average sea-surface temperatures that periodically develop across the east-central equatorial Pacific, **The periodic cooling of sea-surface temperatures across the east-central equatorial Pacific***]
3. Which of the following is a direct greenhouse gas? [*Argon, Nitrogen, **Nitrous Oxide**, Sulfur Dioxide*]
4. During what time of the day does relative humidity typically peak? [*4am-6am, 12pm-3pm, 3pm-6pm, 9pm-12am*]
5. Which of the below holds the most carbon dioxide (CO₂) on Earth? [*Atmosphere, Mountains, **Ocean**, Soil*]
6. How has the global average temperature changed since the industrial revolution? [*Warmer by more than 0.5°C (0.9°F), **Warmer by more than 1°C (1.8°F)**, Warmer by more than 1.5°C (2.7°F), Warmer by more than 2°C (3.6°F)*]
7. Which of the following is the leading cause of weather-related deaths in the US? [***Extreme heat**, Tornadoes, Flood, Lightning*]

8. What is the leading cause of coral bleaching? [*CO₂ dissolved in ocean water, Ocean pollution, **Ocean warming**, Tropical cyclones*]
9. Where have some of the strongest and earliest impacts of global warming occurred? [*Near the equator, **Northern latitude**, South American continent, Impacts of global warming are equally distributed across the planet*]
10. What percentage of heat from global warming has the ocean absorbed in the past 40 years? [*10%, 30%, 70%, **90%***]

Strategy and Media

The next set of questions asks about your prediction strategies and learnings, as well as your experience of the prediction process.

§ Tell us about one bet for which you predicted the outcome correctly (e.g., “Will Biden win the presidency?”): [*blank textbox*]

§ Write one thing you believe you learned from participating in the 4-week prediction market (i.e., a fact, a strategy, a data source, etc.): [*blank textbox*]

§ Were there times when you placed a bet that conflicted with your personal beliefs (i.e., you believe that the world is flat but made predictions that aligns with a view that the world is round)? [1 (*Never*) —6 (*Very frequently*)]

§ Would you say that success/failure in past predictions changed your betting strategy in future predictions? [1 (*Did not change at all*) —7 (*Changed extremely*)]

§ In a few sentences, what was the strategy you used to make your predictions (i.e., which side to take)? [*blank textbox*]

§ In a few sentences, what was the strategy you used to determine the amount of money to allocate to predictions? [*blank textbox*]

§ Please rank the sources by their legitimacy for predictions on topics related to 'climate change'. [*CNN; NASA; Breitbart; Fox News; ABC News; CNBC; NewsMax; Republican climate science research groups such as www.republicen.org; Academic climate institutes such as droughtmonitor.unl.edu; Academic publications; Government agencies such as www.ncdc.noaa.gov, www.epa.gov, waterwatch.usgs.gov; Climate activists' non-profits such as climateactiontracker.org, www.opensecrets.org, waterwatch.usgs.gov; International news sources (i.e., *The Guardian, The Economist, etc.*); Twitter feeds by scientists and climate experts; Social media posts by people in your network (Twitter, Facebook, etc.). Could include quotes of sources from the above (i.e., NASA, Fox News, etc.)*]

§ List the sources you typically use to consume your news: [*blank textbox*]

§ Specifically, in the context of climate science, what sources do you use to generate your opinions on the topic, if any? [*blank textbox*]

Future Predictions

Market #1

Topic: Great Lakes

Bet: Will the water level at Lake Mead be 1,030 feet or lower at the start of 2023?

Source: <https://mead.uslakes.info/Level/>

Expiration: January 1, 2023 23:59 EST

Bet amount (USD): [0.1 – 5.0]

Market #2

Topic: Global Warming

Bet: Will the year 2022 be among the 3 hottest years on record?

Source: <https://data.giss.nasa.gov/gistemp/graphs/>

Expiration: January 4, 2023 23:59 EST

Bet amount (USD): [0.1 – 5.0]

Market #3

Topic: Wildfires

Bet: Will the number of wildfires in California in 2022 be more than 9,000?

Source: <https://www.fire.ca.gov/incidents/2022/>

Expiration: January 4, 2023 23:59 EST

Bet amount (USD): [0.1 – 5.0]

Market #4

Topic: Plant Life

Bet: Will the Peak Bloom Date for Cherry Trees around Washington, D.C. next year be earlier than March 22, 2023?

Source: <https://nationalcherryblossomfestival.org/bloom-watch/>

Expiration: May 1, 2023 23:59 EST

Bet amount (USD): [0.1 – 5.0]

Final questions

§ If you had to guess what the study was about, what would your best guess be? [*blank textbox*]

§ Please leave us feedback if you want. [*blank textbox*]

Table T19. Pre-/Post-surveys items in Study 2 which were not analyzed. Text in blue marks the question. Text in black depicts the potential answers in multiple-choice items. Bold text corresponds to the correct answer in knowledge questions.

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n/a | Confirmed

- | | | |
|-------------------------------------|-------------------------------------|--|
| <input type="checkbox"/> | <input checked="" type="checkbox"/> | The exact sample size (n) for each experimental group/condition, given as a discrete number and unit of measurement |
| <input type="checkbox"/> | <input checked="" type="checkbox"/> | A statement on whether measurements were taken from distinct samples or whether the same sample was measured repeatedly |
| <input type="checkbox"/> | <input checked="" type="checkbox"/> | The statistical test(s) used AND whether they are one- or two-sided <i>Only common tests should be described solely by name; describe more complex techniques in the Methods section.</i> |
| <input type="checkbox"/> | <input checked="" type="checkbox"/> | A description of all covariates tested |
| <input type="checkbox"/> | <input checked="" type="checkbox"/> | A description of any assumptions or corrections, such as tests of normality and adjustment for multiple comparisons |
| <input type="checkbox"/> | <input checked="" type="checkbox"/> | A full description of the statistical parameters including central tendency (e.g. means) or other basic estimates (e.g. regression coefficient) AND variation (e.g. standard deviation) or associated estimates of uncertainty (e.g. confidence intervals) |
| <input type="checkbox"/> | <input checked="" type="checkbox"/> | For null hypothesis testing, the test statistic (e.g. F , t , r) with confidence intervals, effect sizes, degrees of freedom and P value noted <i>Give P values as exact values whenever suitable.</i> |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> | For Bayesian analysis, information on the choice of priors and Markov chain Monte Carlo settings |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> | For hierarchical and complex designs, identification of the appropriate level for tests and full reporting of outcomes |
| <input type="checkbox"/> | <input checked="" type="checkbox"/> | Estimates of effect sizes (e.g. Cohen's d , Pearson's r), indicating how they were calculated |

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Policy information about studies with [human participants or human data](#). See also policy information about [sex, gender \(identity/presentation\), and sexual orientation](#) and [race, ethnicity and racism](#).

| | |
|--|--|
| Reporting on sex and gender | Findings apply to all sexes and genders. Demographic characteristics were collected based on self-reporting through the participant recruiting platform ("Prolific"). These attributes were not relevant to the study design. Study 1 included 72 women and 71 men. Study 2 included 318 women and 346 men. |
| Reporting on race, ethnicity, or other socially relevant groupings | Findings apply to all races and ethnicities. Demographic characteristics were collected based on self-reporting through the participant recruiting platform ("Prolific"). These attributes were not relevant to the study design. Other socially relevant data collected included age, education level, income, political ideology, and number of children. Only political ideology was relevant for the results. |
| Population characteristics | Complete population characteristics appear in the Supplementary Information ("Descriptive Information") for both Study 1 and Study 2. |
| Recruitment | Participants for Study 1 were recruited online using "Prolific" and through the Reddit "Climate Change skeptics" group. Participants for Study 2 were recruited online using "Prolific". |
| Ethics oversight | Study protocols were authorized by Columbia University's Institutional Review Board and Northwestern University's Institutional Review Board. |

Note that full information on the approval of the study protocol must also be provided in the manuscript.

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All studies must disclose on these points even when the disclosure is negative.

| | |
|-------------------|--|
| Study description | Participants completed surveys before and after engaging in a prediction market. The surveys measured their climate concerns, support for climate action, and climate knowledge. Between the surveys, participants were randomly assigned to either engage in a climate prediction market (treatment), or a control group. In Study 1 (n=143) the control group sat idle, while in Study 2 (n=664) the control group engaged in a sports/entertainment prediction market. During the prediction period, participants in the climate prediction market made bets about future climate outcomes (i.e., "Will the number of wildfires in California exceed 5,500 by August 8, 2022?"). |
| Research sample | Participants in Study 1 (n=143; average age: 35.9 years old; 50.5% female) were recruited online using "Prolific Academic" and Reddit. The sample was intentionally skewed towards extreme and polarized views regarding climate change. Participants in Study 2 (n=664; average age: 42.6; 47.9% female) were recruited online using "Prolific Academic". The participants pool constituted a representative sample. |
| Sampling strategy | Sample sizes were determined to ensure statistical significance. |
| Data collection | Data were collected online using Qualtrics and a dedicated experiment website (www.c-hedge.com). |
| Timing | Data for Study 1 were collected between September 1, 2018, and November 15, 2018. Data for Study 2 were collected between July 17, 2022, and September 14, 2022. |
| Data exclusions | Study 1: 17 participants were excluded from the analysis. Three were excluded because they did not complete the required surveys, five because they failed an attention check question in either the Pre-/Post-survey, and nine because they did not fulfill the requirement to use the entirety of the allotted \$20. Study 2: 749 participants were excluded from the analysis. Those included participants who took less than two minutes to complete the Pre-Survey, or failed an attention check embedded in the survey (n=134), as well as participants who were at ceiling (27 or 28, on a 4-28 scale) in their answers to the Pre-Survey questions about climate concern (n=615). |
| Non-participation | Participants that were dropped did so because they did not manage to use their entire allotted budget. These were notified in advance that they do not qualify for the Post-Survey and elected to drop. |
| Randomization | Participants were randomly assigned to "treatment" and "control" conditions. |

Reporting for specific materials, systems and methods

We require information from authors about some types of materials, experimental systems and methods used in many studies. Here, indicate whether each material, system or method listed is relevant to your study. If you are not sure if a list item applies to your research, read the appropriate section before selecting a response.

Materials & experimental systems

- | n/a | Included in the study |
|-------------------------------------|--|
| <input checked="" type="checkbox"/> | <input type="checkbox"/> Antibodies |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> Eukaryotic cell lines |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> Palaeontology and archaeology |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> Animals and other organisms |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> Clinical data |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> Dual use research of concern |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> Plants |

Methods

- | n/a | Included in the study |
|-------------------------------------|---|
| <input checked="" type="checkbox"/> | <input type="checkbox"/> ChIP-seq |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> Flow cytometry |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> MRI-based neuroimaging |