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# ENVIRONMENTAL RESEARCH CLIMATE



## PAPER

# Frequent pro-climate messaging does not predict pro-climate voting by United States legislators

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Supplementary material for this article is available [online](#)

## Abstract

Legislators who frequently advocate for climate action might be expected to cast more pro-climate votes, but pro-climate messaging alone may not predict actual voting behavior. We analyzed 401 539 tweets posted by 518 United States federal legislators over the 6 months prior to the 2020 election and identified 5350 of these as containing climate-relevant messaging. Of the 4881 tweets that we coded as promoting climate awareness or supporting action ('pro-climate'), 92% were posted by Democratic legislators while all 138 tweets undermining climate awareness or opposing action ('anti-climate') were posted by Republicans. Constituent support for Congressional climate action was only weakly related to the rate of pro-climate tweeting by legislators. Overall, we found that increased pro-climate tweeting was not a significant predictor of pro-climate voting when controlling for party affiliation and constituent support for climate action. We conclude that climate-concerned voters would be best served by using party affiliation rather than climate-related messaging to judge the pro-climate voting intentions of United States legislators.

## 1. Introduction

Voters rely on a range of heuristics including party affiliation (Dancey and Sheagley 2013), group endorsements (Lau and Redlawsk 1997), and ideology (Lau and Redlawsk 2001) to inform their voting decisions. More intuitively, campaign messaging may also help voters to form impressions of candidates (Lodge *et al* 1995, Holbrook 1999). Since voters can adopt many different strategies for decision-making, researchers have investigated how successful voters are in casting 'correct' votes, i.e. votes that are consistent with their fully informed preferences (Lau and Redlawsk 1997).

The concept of correct voting is particularly salient for the issue of climate change. The fraction of the United States population classified as 'alarmed' regarding climate change has almost tripled since 2014 (Goldberg *et al* 2020a) and in July of 2021 Americans described climate change as the second most important issue facing their nation (The Economist 2021). Long-term demographic shifts (Motta 2020) combined with the intensification of extreme weather suggest that climate change could remain a prominent (though polarized) political issue in the United States (Zanocco *et al* 2019, Hazlett and Mildenerger 2020, Cohen 2021, Liao and Junco 2022). If climate change becomes increasingly important to voters there may be motivation for political candidates to 'play to the crowd' by at least trying to communicate competence in that domain (Ansolabehere and Iyengar 1994, Boydston *et al* 2013).

Progress on addressing climate change requires politicians to not just claim climate competence, but to display it in their legislative decisions. In the past, states that elected legislators with stronger

pro-environmental voting records experienced lower historical growth in emissions (Dietz *et al* 2015) and the difference in emissions caused by electing one party and not another has been shown to be substantial (Wynes *et al* 2021b). One international analysis of climate policies found that each new act of national climate legislation was associated with a 1.79% drop in long term annual carbon dioxide emissions per unit of gross domestic product (Eskander and Fankhauser 2020) and another found that policies which encouraged renewable energy growth and displaced fossil fuels were partially responsible for declining emissions in 18 developed nations (Le Quéré *et al* 2019). Given the evidence for the link between voting for pro-climate candidates and actual emissions reductions, it is important that motivated voters can correctly identify pro-climate candidates. So when it comes to climate change, should United States voters rely on what a candidate says, or on some other heuristic to inform their decision-making?

Past research has shown a relationship between candidate communication and legislative choices (Ringquist and Dasse 2004) with candidates regularly fulfilling the majority of their campaign promises (Pétry and Collette 2009). In the United States, legislators who raise a specific issue in campaign television ads are more likely to go on to either sponsor or introduce new legislation on that issue during the following term (Sulkin 2009). Thus, despite large majorities of United States voters believing that politicians fail to keep their promises (Rasmussen Reports 2014), voters can typically expect a politician's pledges to preview their actions. This is a helpful guide, based on a finding that has been replicated in many democracies (Naurin 2011, Duval and Pétry 2018), but may not be useful in all circumstances. What happens when opposing candidates lay claim to the same issue, for instance? Can volume of communication or the messaging frames employed by legislators help a voter discern between candidates?

Legislators seeking to increase public support for climate change may also want to better understand the efficacy of their communication strategies. Fortunately, there is a substantial body of research which has already investigated climate communication in the United States. A major finding has been that concern for climate change is partially driven by signals from elites (Brulle *et al* 2012, Carmichael and Brulle 2017, Merkley and Stecula 2020, Rinscheid *et al* 2020), which considerably raises the importance of messaging by federal politicians. While large majorities of citizens aligned with the Democratic Party are already concerned about climate change, Republicans, led by their elected officials, tend to be much more dismissive of the issue (Dunlap *et al* 2016, Fiorino 2022). However, climate change communication delivered by conservative messengers (and using conservative frames) is more likely to resonate with conservative audiences (Bolsen *et al* 2019, Hurst and Stern 2020, Goldberg *et al* 2021) and scientific corrections delivered by Republican elites are more persuasive to Republicans (Benegal and Scruggs 2018). Republicans also prioritize climate policies more when they perceive fellow Republicans as prioritizing climate policy (Cole *et al* 2022). Taken together, this research demonstrates the value of tracking the current messaging strategies of Republican elites, including US Republican legislators.

Though Republican legislators have disproportionate influence on the beliefs of climate skeptical Americans, all legislators have large audiences and powerful platforms. So even if a change in communication frame only results in a two- or three-point percentage change in opinion, it is still worthwhile for legislators to maximize their impact. Past research has shown that messages focusing on the public health impact of climate change (Myers *et al* 2012) or on the potential for new jobs in clean energy (Diamond and Zhou 2021) can perform better than typical environmental frames. Additionally, best practice in climate change communication includes focusing on near-term, localized effects of climate change, rather than on distant outcomes (van der Linden *et al* 2015). Are legislators employing these best practices?

Conversely, there may be evidence of legislators employing bad-faith argumentation against climate action. This could take the form of attacks against climate science itself, which have been employed by industrial advocates and politicians for decades (McCright and Dunlap 2003), or it could be manifested in the form of other argumentative techniques such as ad hominem attacks against climate scientists (Cook *et al* 2018). Recently, more subtle approaches have also become common. Lamb *et al* (2020) have identified policy-oriented discourses that seek to prevent or delay climate action, including four broad strategies that would seek to “redirect responsibility”, “push non-transformative solutions”, “emphasize the downsides” of climate policy, or “surrender” to climate change. For example, pushing non-transformative solutions includes strategies like ‘technological optimism’ where the speaker urges the pursuit of future technologies at the expense of existing solutions, or ‘no sticks, just carrots’ where someone claims that society will only respond to voluntary measures and that restrictive policies are not acceptable (Lamb *et al* 2020).

Here we examine the Twitter behavior of United States Members of Congress for the 6 months preceding the 2020 Presidential election. By manually coding tweets as either ‘pro-climate,’ ‘neutral,’ or ‘anti-climate,’ we identified those legislators who signal commitment to the issue of climate change and those who undermine proven solutions or downplay the issue. We then compare levels of pro-climate tweeting to Congressional voting behavior as measured by League of Conservation Voters scorecards, specifically on climate issues. Finally, we examine the text of climate-relevant tweets by legislators to provide insight into

those who post pro-climate messages but do not cast pro-climate votes and to understand if legislators can improve their messaging strategies.

## 2. Methods

Tweets were scraped using the `rtweet` package in R (Kearney 2019), over a six-month period prior to the 2020 United States general election (from 20 April to 3 November). Twitter handles of US representatives (including members of the House and the Senate) were taken from [www.sbh4all.org/](http://www.sbh4all.org/). Some legislators also make use of personal accounts—we included these by supplementing our list of Twitter handles with those used by Green *et al* (2020). We chose to exclude Twitter handles associated with legislators less directly, for instance those Twitter handles associated with congressional committees which a legislator might head, as well as press accounts. Similarly, legislators who do not tweet or who retired prior to April of 2020 were excluded from this analysis, as were officials who do not participate in floor votes, such as delegates from Puerto Rico. We also filtered tweets for distinct text and screen names, meaning that if a legislator retweeted their own tweet or posted two tweets with identical text from the same screen name, only one version of this tweet was retained.

To put our data in the context of more historical patterns of Congressional climate tweeting we also downloaded data from the 116th US Congress Tweet ID dataset (Wrubel and Kerchner 2020) using the keywords described below. Out of 2 817 747 tweets in the 116th US Congress Tweet ID dataset, 22 198 tweets were selected as climate change related. While the tweets were collected between 27 January 2019 and 7 May 2020 from the Twitter API, the dataset also includes older tweets from 2010 onwards. For this dataset we only checked for climate-relevant keywords and did not perform the same in-depth analysis as was done for the smaller, more recent sample.

Additional data on each representative's voting behavior was downloaded from [www.voteview.com/data](http://www.voteview.com/data). Data on representatives' environmental voting records was downloaded from the League of Conservation Voters 2019 and 2020 scorecards. Past research has found that legislators with high scores tend to represent states with lower growth in greenhouse gas emissions (Dietz *et al* 2015), and legislators with low scores tend to accept more donations from oil and gas companies (Goldberg *et al* 2020b). Because we were specifically interested in climate change, we focused on only those floor votes which the League of Conservation Voters described as being related to climate change. Public opinion data for the different congressional districts and states was obtained from the Yale Climate Opinion Maps 2020 (Howe *et al* 2015). Here we focus on what we considered to be the most relevant variable for an elected official in our sample: 'Estimated percentage who think Congress should be doing more/much more to address global warming'. We refer to this in the text as 'District support for Congressional climate action'.

Using methods adapted from (Wynes *et al* 2021a) we filtered the database of tweets to those containing a set of relevant keywords, including: 'global warm\*', 'climat\*', 'ghg', 'greenhouse gas\*', 'fossil', 'carbon', and 'emission'. Tweets containing these keywords are referred to in the paper as 'climate-relevant tweets'. Each tweet excluded by this filtering process was automatically classified as 'neutral' while the climate-relevant tweets were coded by two raters as either 'pro-climate', 'anti-climate', or 'neutral'. Pro-climate tweets are those tweets that encourage action or awareness about climate change while anti-climate tweets deny the existence or severity of climate change, discourage climate action or promote the use of fossil fuels. A total of 5350 tweets were coded in this way (note that only unique tweets were initially coded, and duplicate tweets, such as retweets of the same text by multiple legislators, were then assigned the same code). Tweets were coded in a spreadsheet both to streamline the coding process, and so that the raters were mostly blinded as to the identity of the tweeter. However, this meant that emoticons and linked images were also not visible, except in cases when the raters were unsure of how to classify the tweet, in which case they opened the URL and viewed it on the Twitter platform. Full instructions for coding are available in the supplementary material 1: methods. Raters agreed on 97.4% of tweets ( $\kappa = 0.846$ ). For another example of manually coding political tweets please see Himelboim *et al* (2016).

To check if the filtering process was missing tweets which could be pro- or anti-climate, we randomly selected 500 tweets from those that were excluded. Of these 500, only two were somewhat related to climate change (one was part of a technical thread on decarbonization technologies and the other was about clean energy) while 11 were distantly related to climate change (e.g. discussing wildfires or hurricanes but not mentioning climate change in any way). None of these tweets would have been coded as pro-climate.

After all relevant tweets were coded, raters discussed those tweets where they disagreed until a consensus was achieved (Kuckartz 2014), and this consensus code was then used for analysis going forward. In visualizations and statistics in the paper we calculated a normalized, 'pro-climate tweet rate' defined as the difference between the pro- and anti-climate tweets divided by the total number of tweets posted by a legislator. Thus, negative values indicate more anti-climate than pro-climate tweets, whereas positive values

indicate more pro-climate than anti-climate tweets. This is helpful because some legislators tweeted thousands of times during the months leading up to the election, while many tweeted less than 100 times. Our intention in choosing pro-climate tweet rate over other metrics like total pro-climate tweets is to best approximate how followers would perceive their representatives, (e.g. a legislator who only posted ten pro-climate tweets out of a total of 20 is more similar to a legislator with 1000 pro-climate tweets out of 2000 than they are to a legislator with ten pro-climate tweets out of 2000). For figure 2 and correlational testing, two legislators with fewer than ten tweets in total were removed from the analysis.

We also determined the most frequent number of words used by members of both parties when tweeting about climate change. To do this we first filtered out all tweets which were not coded as either 'pro-climate' or 'anti-climate'. We then removed punctuation, symbols and English stopwords (e.g. 'myself', 'our') and then ranked words by frequency.

To test for a relationship between the frequency of pro-climate tweeting and pro-climate voting, we ran a zero-inflated negative binomial model. In the model the outcome variable was the number of pro-climate votes placed by a legislator, with an offset term to account for the number of opportunities to place a vote. Zero-inflated negative binomial regression is appropriate since it can be used to fit overdispersed count data with excess zeros (Hua et al 2014). Computer code and data are available at: <https://osf.io/a8znp/m> (Wynes et al 2022).

### 3. Results

#### 3.1. Overview of climate-relevant tweeting

We collected 401 539 tweets from 518 representatives. 276 legislators were Democrats, 240 were Republicans and two were independents. A total of 5350 tweets were selected as relevant to climate change by the initial search (as a frame of reference, during that same time, the words 'COVID', 'virus', 'vaccine', and 'pandemic' were mentioned 75 086 times). Of that sub-sample, 4881 tweets were coded as pro-climate and 138 were coded as anti-climate (table 1). Pro-climate tweeting was not equal between the parties; Democrats posted an average of 16.34 (SD = 35.44) pro-climate tweets during the analysis period compared to 1.18 (SD = 5.18) for Republicans ( $t(288.47) = 7.02, p < 0.001$ ). 4511 (92%) of the pro-climate tweets were posted by Democratic legislators and all 138 anti-climate tweets were posted by Republican legislators (supplementary table 2). 90% of Democrats posted at least one pro-climate tweet and 37% posted 10 or more, compared to 28% and 3% respectively for Republicans (see Supplementary data for details). The difference in pro-climate tweeting between the two chambers was far less distinct, with senators posting a mean of 14.45 (SD = 38.20) pro-climate tweets in the analysis period compared to 8.22 (SD = 23.96) for members of the United States Congress ( $t(118.27) = -1.56, p = .122$ ).

During the 6 months before the election, climate-relevant tweeting was clustered at particular moments (figure 1). Peaks coincided with Earth Day (22 April 2021), promotion of the Climate Crisis Action Plan<sup>6</sup> (30 June), promotion of the Case for Climate Action<sup>7</sup> (25 August), and the West Coast wildfires (10–26 September). We also consulted an older Twitter database and found that this pattern of tweeting is consistent with observations from previous years (see supplementary material 2). For instance, large spikes occurred in 2019 and 2020 for Earth Day as well as for the passage of the Climate Action Now Act (H.R.9.) and for the September 2019 Climate Strikes.

#### 3.2. Voting and social media behavior of legislators

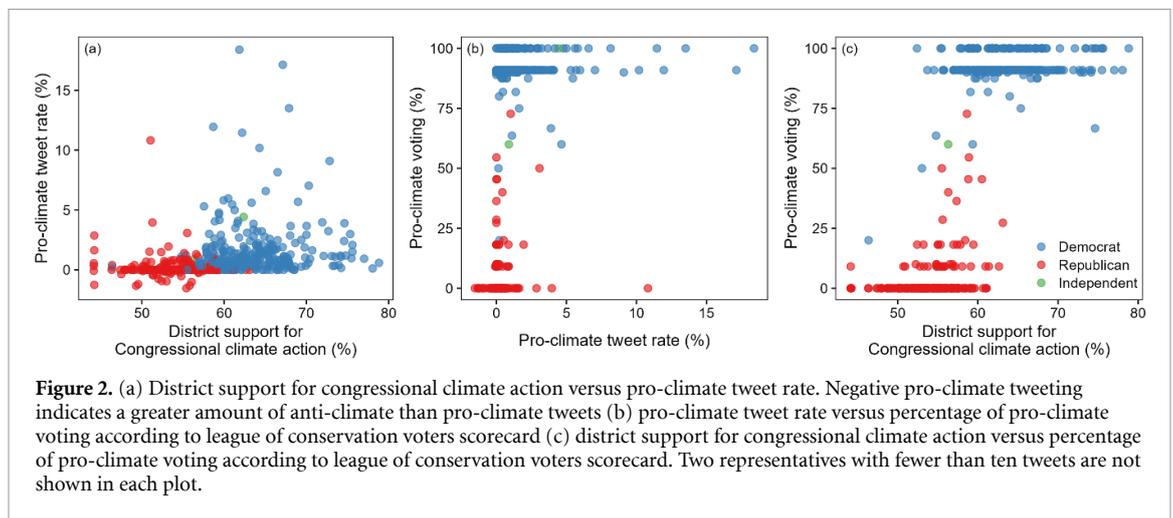
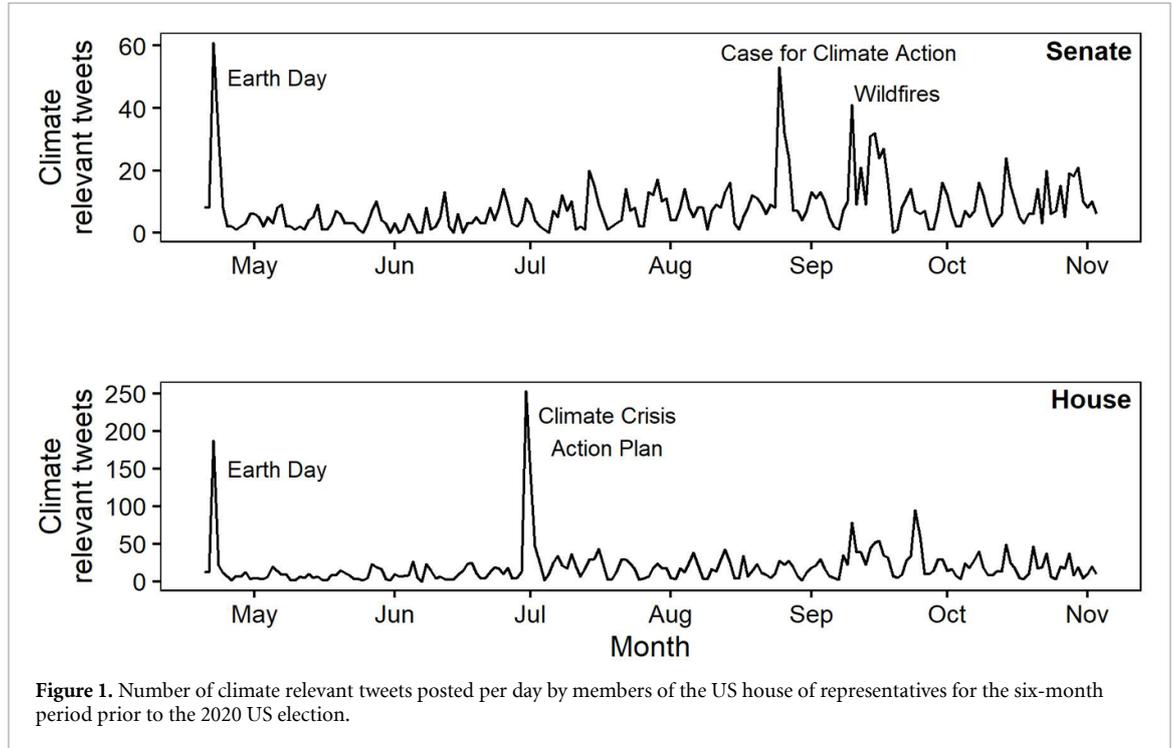
While Democrats dominated the issue of climate change rhetorically, there were also some Republicans who posted frequent pro-climate messages. However, this does not appear to be associated with district support for Congressional climate action in an obvious way (figure 2(a)). The correlation between district support for Congressional climate action and pro-climate tweet rate was very weak both for Republicans ( $r = -0.08$ , 95% CI [-0.21, 0.04],  $p = .20$ ) and for Democrats ( $r = 0.08$ , [-0.04, 0.19],  $p = .19$ ), though stronger for all legislators combined ( $r = 0.30$ , [0.22, 0.38],  $p < .001$ ). Since pro-climate tweet rate is sensitive to the number of tweets (e.g. legislators with low total tweets can have a high pro-climate tweet rate by only posting a few pro-climate tweets) we also conducted the analysis with total number of pro-climate tweets finding that correlations do not change direction or vary substantially in magnitude, though the relationship between total pro-climate tweeting and district support for Congressional climate action is statistically significant for Democrats (supplementary materials 3 and 4).

<sup>6</sup> See <https://climatecrisis.house.gov/report> for details of this plan, produced by the House Select Committee on the Climate Crisis.

<sup>7</sup> See [www.democrats.senate.gov/climate](http://www.democrats.senate.gov/climate) for details of this report produced by the Senate Democrats' Special Committee on the Climate Crisis.

**Table 1.** Descriptive data for legislators in our sample.

	Senators	House representatives	Pro-climate tweets	Anti-climate tweets	Total tweets
Republicans	53	187	283	138	145 528
Democrats	45	231	4511	0	253 775
Independents	2	0	87	0	2236
Total	100	418	4881	138	401 539



Similarly, the pro-climate tweet rate was weakly correlated with pro-climate voting (figure 2(b)). This was true both for the Republican Party ( $r_{\tau} = 0.15$ , 95% CI [0.06, 0.23],  $p = .011$ ) and the Democratic Party ( $r_{\tau} = 0.14$ , [0.06, 0.21],  $p = .004$ ). Although district support for climate action and party affiliation could both be reasonably expected to contribute to pro-climate voting, party affiliation seems to dominate (figure 2(c)). For instance, there were 70 Republican legislators in our sample with a district support for Congressional climate action above 55%, but with a pro-climate voting record of 0%. Overall, the correlation between district support for Congressional climate action and pro-climate voting was stronger for Republicans ( $r_{\tau} = 0.24$ , 95% CI [0.16, 0.32],  $p < .001$ ) than for Democrats ( $r_{\tau} = 0.09$ , [0.01, 0.16],  $p = .068$ ). Prominent Democratic deviations included Senator Joe Manchin, and Speaker Nancy Pelosi who represent areas where support for more climate action on the part of Congress was estimated at 46% and 75%, respectively. Senator Manchin is the only Democrat elected in a region with less than 50% district support for

**Table 2.** Results from the zero-inflated negative binomial model predicting pro-climate voting.

	Coefficient	Standard error	<i>p</i> -value
Counts portion of the model			
Pro-climate tweet rate	.363	.861	.673
District support for climate action	.005	0.004	.234
Party (Democrat)	.228	0.448	.611
(Republican)	−2.290	0.475	<0.001
Constant	−.625	0.506	.217
Logistic portion of the model			
District support for climate action	−0.585	0.086	<0.001
Voting opportunities	0.015	0.144	0.917
Constant	31.178	4.959	<0.001

Note: N= 518, Log Likelihood = −753.6.

Congressional climate action and Speaker Pelosi is the only legislator with district support for Congressional climate action above 70% who also has a pro-climate voting record below 90% (Speaker Pelosi's pro-climate voting record is 67%, which may be explained by strategic votes placed as House Speaker).

Since legislators in the same party can operate in such different political contexts, it is helpful to account for constituent preferences when assessing the relationship between pro-climate tweeting and pro-climate voting. We found no evidence that increased pro-climate tweeting was associated with increased pro-climate voting when controlling for party affiliation and constituent support for Congressional climate action (table 2). From the perspective of a constituent evaluating candidates, party appears to be a more useful predictor of pro-climate voting than frequency of pro-climate social media posts.

### 3.3. Textual analysis

Although the frequency of pro-climate tweeting may not be a strong indicator of pro-climate voting, the actual content of a pro-climate tweet could give voters a better indication of legislator voting intentions. For instance, several Republican legislators tweet frequently about climate change, but rarely or never vote in favor of pro-climate legislation. Does the content of their tweets reveal a lack of climate ambition? Supplementary table 1 shows the ten Republican legislators with the highest number of pro-climate posts with at least 1% of all posts being pro-climate and includes their most retweeted climate-relevant tweet.

Many of the Republican pro-climate tweets focused on carbon capture and storage: 'capture' was the twelfth most popular word used by Republicans when tweeting about climate change (figure 3). Other Republican tweets did not cast doubt on the existence of human-caused climate change, but cautioned against the use of strong regulations, or described the importance of fossil fuels in solving climate change (table 3). These rhetorical approaches to climate change have sometimes been described as 'discourses of climate delay' where 'proponents of climate delay ... argue for minimal action or action taken by others' (Lamb *et al* 2020).

Climate-relevant tweets from Democrats were more likely to take on an ambitious tone, framing climate change as a crisis, for instance (figure 3). Democrats mentioned 'communities' 582 times, which partially reflects attempts to localize the impacts of climate change (e.g. coastal flooding and wildfire risk) but also a climate justice frame (e.g. 'Communities of color are disproportionately affected by climate change'). Democrats mentioned 'health' 405 times, often describing the negative public health effects of climate and polluting fossil fuels, but also describing healthy ecosystems or listing climate change as one priority among many (including health care). Although both parties mentioned 'jobs' frequently while discussing climate change (Democrats 376 times, Republicans 53 times), the messages were quite distinct. Republican tweets asserted that climate policies would eliminate fossil fuel jobs or touted policies that will create jobs without harming the fossil fuel industry (jobs in nuclear energy, carbon capture and storage, and tree planting). Democrat tweets made claims that their climate policies would create jobs, often described with superlatives ('millions of good-paying jobs').

### 3.4. Discussion

Pro-climate voters would benefit from identifying political candidates who are more likely to pass robust climate legislation. Our analysis of social media posts by United States Members of Congress indicates that party affiliation is a far superior predictor of pro-climate voting than the rate of pro-climate messages posted to Twitter.

The inability of pro-climate tweeting to predict pro-climate voting is driven by two factors. First, a small number of Republican legislators could be described as 'playing to the crowd', in that they posted frequent pro-climate tweets but rarely or never voted in favor of pro-climate legislation. This approach was still

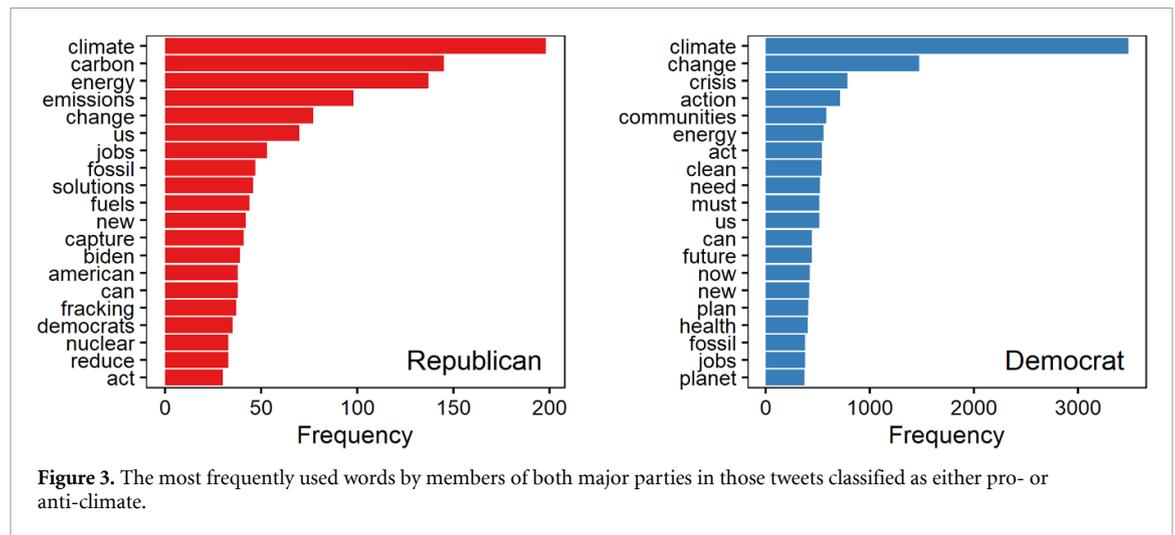


Figure 3. The most frequently used words by members of both major parties in those tweets classified as either pro- or anti-climate.

Table 3. Examples of discourses of delay.

Discourse of delay	Description of discourse of delay <sup>a</sup>	Tweet examples	Legislator
Appeal to social justice	Centering the social impacts of renewable energy or other climate solutions, while arguing that they are too costly or burdensome	California has prioritized unrealistic climate goals at the cost of the everyday wellbeing of its residents. Renewable energy sources are important, but we must be able to balance reducing emissions with reliability of utilities for American consumers <a href="https://t.co/CHFKaSxMhf">https://t.co/CHFKaSxMhf</a> .	David McKinley
Fossil fuel solutionism	Claiming that the fossil fuel industry is part of the solution to climate change	Reviewed progress of #ProjectTundra today as it, and other CCUS tech, will allow us to continue harnessing our abundant coal reserves, which are central to maintaining affordable and reliable electricity + also reducing emissions <a href="https://t.co/vQd4k1DUHf">https://t.co/vQd4k1DUHf</a> .	John Hoeven
No sticks, just carrots	Advocating for the use of only voluntary policies and against the use of restrictive policies	On #Earthday, key to tackling climate change: American innovation. Not higher taxes/energy costs, or killing US energy jobs w/#GreenNewDeal. Innovation made US the global energy leader. Will make us driving force for clean, affordable energy as solution—send to world.	Kevin Brady
Technological optimism	Exaggerating the ability of technological progress to achieve emissions reductions in the future in order to draw support away from existing, effective measures	We hear a lot about electric vehicles, but what would they do for greenhouse gas emissions? The answer is not as much as my colleagues across the aisle would like you to believe. Fossil fuels still back wind and solar. We need to instead work on next-generation nuclear energy <a href="https://t.co/zHdynlAaQv">https://t.co/zHdynlAaQv</a> .	Bruce Westerman
Whataboutism	Arguing that other countries or sectors are more polluting and therefore bear more responsibility for action	Happy #EarthDay! The United States is leading the entire world in reducing carbon emissions while China remains the world’s largest polluter of our air and water.	Paul Gosar

<sup>a</sup> Descriptions of discourses of delay adapted from (Lamb et al 2020).

relatively rare (only 28% of Republicans posted at least a single pro-climate tweet during the study period and only 3% posted more than 10). Much of Republican pro-climate tweeting also focused on measures that do not curtail the use of fossil fuels (carbon capture and storage, tree planting and technological innovation) while offering sometimes subtle arguments for their continued usage (‘discourses of climate delay’).

Second, many Democratic legislators from districts with broad support for climate action consistently placed pro-climate votes but did not signal their climate credentials with substantial pro-climate tweeting. If these legislators have no strategic, electoral justification for limited climate messaging then this may represent a missed opportunity for the type of elite signaling that drives climate concern (Carmichael and

Brulle 2017, Rinscheid *et al* 2020). In such cases, citizens and activists could potentially pressure legislators into taking stronger stances in their messaging (Wynes *et al* 2021a). Indeed, our findings show that climate-relevant tweeting in general is relatively rare. Only about 1% of all tweets were initially flagged as relevant to climate change, whereas 19% of tweets were flagged as related to COVID-19.

Our results also suggest that legislators may not be voting in line with the preferences of their constituents; 29% of Republicans did not cast any pro-climate votes in the two most recent sessions of Congress despite representing areas with greater than 55% support for increased Congressional climate action. There is evidence that this divergence could be caused by legislator misperceptions of constituent preferences, partially due to interactions with business group interests (Hertel-Fernandez *et al* 2019) or by disproportionate contact from Republican citizens (Broockman and Skovron 2018). Alternatively, polling may overstate citizen interest in stronger climate policies; status quo bias (Dyck and Pearson-Merkowitz 2019, Lang *et al* 2021) and acquiescence bias (Motta *et al* 2019) can create gaps between the preferences stated during a survey and those revealed while voting. More theoretically, one could see these findings as contributing additional evidence to the theory that United States policymaking is essentially unresponsive to the public will (Gilens and Page 2014). Still, for advocate groups or others who might favor evidence siding against this theory (Burstein 2003, Page and Shapiro 2014, Abou-Chadi and Krause 2018), the presence of legislators whose voting records do not match their own rhetoric or the preferences of their constituents hints at an opportunity to campaign for a public commitment to ambitious climate policies.

Since Democrats are the party most responsible for communicating on climate change as well as for voting in favor of pro-climate legislation, it is important that they are delivering effective messages. We highlighted some key themes in Democratic messaging about climate change including: connecting climate change to public health concerns, focusing on the local, and framing it as a crisis. Several studies have suggested that public health frames result in increased public engagement (Stokes and Warshaw 2017, Hanus *et al* 2018, Kotcher *et al* 2018, 2021) indicating the strategic benefits of such an approach, which was a core legislative strategy of the Obama administration (Workman *et al* 2020). Similarly, a focus by Democratic legislators on the immediate ('now') and the local ('communities') is consistent with best practice, which advises against framing climate change as a distant concern that will affect other nations or generations (van der Linden *et al* 2015). Describing climate change as a crisis or an emergency likewise indicates that climate change is not a distant threat, although one study suggests Twitter news stories using a crisis/emergency framing do not increase public engagement with the issue relative to the stories that simply use the term climate change (Feldman and Hart 2021).

It is also important to understand the audience that elected officials are reaching, or are aiming to reach, with these communications. Twitter users are more politically aware than the general population (Mellon and Prosser 2017) as well as younger and more educated (Pew Research Center 2019). Because of this, a politician using Twitter may be aiming to engage with their base or generate media attention, rather than appealing to the median voter as might be expected in a television ad. This has ramifications on what types of frames are more effective. For instance, public health frames may become less effective if followed by a denialist counter-frame (McCright *et al* 2016). This would be particularly concerning on a debate stage, but less of an issue when reaching out to a sympathetic audience. Similarly, promoting climate change as a crisis or emergency can be seen as less of a strategy to engage the public, and more of a way to redefine the terms of the debate. If climate change is viewed as an emergency, it may allow for exceptions to established procedures and the prioritization of climate over other issues (McHugh *et al* 2021). Alternatively, this framing may simply be performative, intended to please climate advocates, in line with some cities who issued climate emergency declarations to placate social movements (Ruiz-Campillo *et al* 2021).

Our findings add to the literature on climate communication by US political elites, complementing three recent analyses. First, using floor speeches from 1996 to 2015, Guber *et al* (2021) show that Congressional Democrats focus their climate messaging on extreme weather, economic opportunity, school programs and public health while Congressional Republicans focus on fossil fuel usage and climate change denial. Our investigation of more recent Twitter data shows that Democratic messaging has maintained a focus on public health and economic opportunity, consistent with a party focus since the Obama Administration, but also crucially demonstrates the introduction of more subtle forms of climate denial by Republican legislators in recent years ('discourses of climate delay').

Bohr (2021) also investigates environmental communication, focusing on Twitter usage by the 115th House of Representatives. Bohr finds that Republicans of the Climate Solutions Caucus remained silent when the Trump administration withdrew from the Paris Agreement, and that Republicans in general emphasized fossil fuels in their communications, demonstrated by the frequent use of words like 'coal' and 'miner'.

Finally, looking at Members of Congress, governors and city officials for January 2017 to January 2019, Yu *et al* (2021) find no relationship between a jurisdiction's exposure to climate risk and the quantity of statements related to climate change made by politicians, but do find a relationship between a politician's

climate messaging and constituent concern, even when accounting for party. Though this relationship was weaker for federal politicians in their sample it remains slightly at odds with our finding of a non-significant correlation between District support for Congressional climate action and pro-climate tweet rate within parties. It could be that legislators in our study (from the 116th Congress) were somewhat less responsive in their messaging to constituent preferences, but the difference could also be attributed to methodological choices (we used legislators' official twitter accounts as well as their campaign accounts, used slightly different search terms, and differentiated between pro-climate, neutral, and anti-climate tweets whereas Yu *et al* did not).

More broadly, our central finding that party affiliation is the best (tested) predictor of pro-climate voting, is consistent with the well-documented, growing polarization in United States society and Congress (Thomsen 2014, Neal 2020), especially on the issue of climate change (Dunlap *et al* 2016). Under these conditions it is perhaps unsurprising that legislators' voting records are sorted so strongly along partisan lines. Though one might expect legislators representing moderate constituencies to oppose their own party occasionally, evidence suggests that when senators deviate from their party, voters from the opposing party are unlikely to notice (Donnelly 2019). Given the threat to incumbents of 'getting primaried' (having one's own party mount a challenger during primary races) for acting insufficiently partisan (Boatright 2013), legislators have considerable motivation to vote along party lines, and little motivation to deviate. Still, legislators serve a variety of constituencies with different mixes of outpartisans, copartisans, and independent voters, which gives rise to complicated pressures that may explain some of the aberrant voting in our sample (Sulkin *et al* 2015).

We do acknowledge some important limitations to our findings. Twitter is not necessarily a perfect proxy for all campaign messaging, which includes a variety of media channels. Our classification system is limited to three groupings ('pro-climate', 'anti-climate' and 'neutral'), and a more refined system with greater attention paid to the content of communication may yield further insight. Additionally, in this study we focus on federal legislators in the highly polarized United States context (Gustafson *et al* 2019). Given the huge leverage that the United States has over greenhouse gas emissions, this is an important nation for study, but the results may not generalize down to the local level, or across nations. Although we did undertake additional analysis to demonstrate that our results could generalize outside of non-election periods (supplementary figure 1), we did not perform the same detailed analysis on data outside of the six months prior to the 2020 election. Future research could extend our work by testing political messaging using other variables (e.g. floor speeches), expand to other regions or incorporate additional variables into analysis which could also aid voters in making their decisions.

To conclude, for United States citizens, past voting records or endorsements from environmental organizations may aid pro-climate voters in making correct decisions. When those are lacking or difficult to find, as would be the case for most challenger candidates, voters might expect that a candidate's messaging would indicate the candidate's intentions. But given the complex ways that legislators communicate about climate change, our results suggest that United States voters should rely on party affiliation as the most straightforward indicator of willingness to support pro-climate legislation at the federal level.

### Data availability statement

The data that support the findings of this study are openly available at the following URL/DOI: [https://osf.io/a8znp/?view\\_only=4a9b7aed65674294b67c9178ca0de180](https://osf.io/a8znp/?view_only=4a9b7aed65674294b67c9178ca0de180).

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