

Who speaks for climate change in China? Evidence from Weibo

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Abstract Social media provides a new and expanding forum to discuss climate change. Existing research in this area has focused mainly on Twitter and discussions in the United States, while online discussion of climate change in China has been largely unexamined. To fill this gap, we analyzed discussion about climate change on China's premiere microblogging website, Weibo, over a two month period surrounding the Paris Climate Summit. The results show that institutional users-state media and international actors-dominate the discussion, while Chinese NGOs and public intellectuals are mostly absent from the scene. Discussion on climate change is concentrated in major urban areas, especially in Beijing. A significant proportion of Weibo posts aim to raise climate change awareness; few users discuss topics such as climate science, climate change's actual impacts on China, or China's low-carbon policy measures. Climate change appears as a global threat that has little connection to China's national context.

The rise of digital media has led to a proliferation of scholarship on online climate change communication (Schafer 2012; Koteyko et al. 2015; Pearce et al. 2015). Microblogs, which foster an open exchange of information, are a particularly fruitful platform for examining public perception of climate change (Auer et al. 2014). The current literature examines climate change communication on Twitter regarding its framing (O'Neill et al. 2015), role in contentious politics (Seegerberg and Bennett 2011), network structure (Pearce et al. 2014; Williams et al. 2015), spatial and temporal patterns (Kirilenko and Stepchenkova 2014), sentiments (Cody et al. 2015), and media ecology (Veltri and Atanasova 2015). This literature usually takes Twitter's open and egalitarian potential for granted; indeed, those who tweet about climate change are mostly non-elite users such as individual bloggers and concerned citizens (Newman 2016).

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Existing studies, however, suffer from a significant geographical bias—almost all are based on the Anglo-American cyberspace of Twitter (Schafer 2012). Little is known about the major actors and popular content appearing in China’s online climate change discourses. While there is a lively intellectual debate about the role of social media in China’s environmental movement and governance (Yang and Calhoun 2007; Sullivan and Xie 2009; Fedorenko and Sun 2015; Kay et al. 2015), no empirical study focuses specifically on climate change. This omission leads to blind spots in communicating climate change in China’s contexts. To what extent does Weibo, China’s most popular social media platform, facilitate democratic discussion about climate change? Do Chinese netizens use social media as a platform to push for climate actions? What types of framing catch people’s attention? How is the Chinese government involved in spreading climate change information online? These important questions remain to be addressed.

This article presents the first in-depth analysis of climate change discourse on China’s social media, in particular, on Weibo. Overall, we show that institutional users, rather than individuals, dominate the climate change discourse on Weibo. Surprisingly, a sizable fraction of the institutional users are international actors. We do not see evidence of strong corporate influence as in the case of the USA (Jacques et al. 2008; Farrell 2016a), and unlike the polarized discursive fields on Twitter (Williams et al. 2015) and the US climate policy communities (Jasny et al. 2015; Farrell 2016b), we do not discover noticeable “echo chambers” regarding climate change in China’s cyberspace. Online activity concentrates in urban areas, especially the capital city of Beijing. A significant proportion of Weibo posts are about increasing climate change awareness; few users discuss topics such as climate science, climate change’s actual impacts on China, or China’s low-carbon policy measures. Climate change appears as a global threat that has little connection to China’s national context.

1 Data and research method

Launched in 2009, Weibo is the most popular microblogging service in China (Weibo means microblog in Chinese). Based on its own statistics, Weibo had 212 million monthly active users (MAU) in the third quarter of 2015 (Sina Weibo Data Center 2015), and according to Alexa, an internet traffic data provider, Weibo ranks as the 17th most visited website in the world. Due to its popularity, we chose it as the platform to study discourse about climate change on China’s Internet.

While often recognized as the Twitter equivalent in China, Weibo should be understood as a hybrid of Twitter and Facebook. On Weibo, all users may follow and be followed by other users. As of 2016, top Weibo users have more than 80 million followers. Weibo’s identification policy encourages users to become “verified” (the letter “V” appears alongside a username if an account is verified). Unlike Twitter, which only recognizes “verified” accounts, Weibo uses multiple verification symbols to signal institutional users, such as governments, media, and companies, as well as famous people like movie stars, athletes, and elite Weibo microbloggers.

On Weibo’s interface, a user can post (akin to tweet) a message under 140 characters, use hashtags (#), and mention other users by the @ function. There are three main ways to react to a post on Weibo: (1) click on the “like” button to like a post, (2) “comment” on a post by writing a message which appears in the threaded comments below the post (a feature absent in

Twitter), and (3) “forward” (also known as repost) a post—similar to Twitter’s retweet and Facebook’s “share” button. Any user can view the number of likes, comments, and forwards of a post. In this study, we focused on users’ “forwarding” behavior to inform us of the visibility of a post and the relationship between users.

We purposefully collected Weibo posts during November and December 2015—the 2-month span before, during, and after the Paris Climate Summit—with the intention to capture discussion related to the Summit. To harvest the data, we constructed a web crawler to search for all posts with a topic of “climate change” (*qihou bianhua*) or “global warming” (*quanqiu biannuan*). For each post, we gathered the post content, username (the name of the author), forward numbers, and sending locations. We also collected information regarding the relationship between users: when user A forwards a post from user B, it appears as a directed “edge” from the original poster B to user A.

After obtaining the raw data, we thoroughly cleaned the data to delete posts irrelevant to our research. Most notably, the two most popular search results were about China’s attempt to establish a nature reserve in the conflict-laden South China Sea, and a photos series of the American stand-up comedian George Carlin—neither of which relate to our topic and were consequently removed from the dataset. After cleaning the data, we amassed a dataset of 98,488 posts, forwarded 192,163 times in total, by 47,217 Weibo users during the study period. As popular posts can be published by multiple users, but contain the same topical content, we also manually filtered and combined identical Weibo posts to rank the most popular posts.

We purposefully chose the OpenOrd module of Gephi to visualize the network of Weibo users, mainly because this module enables us to efficiently visualize a large network with thousands or even millions of nodes. Specifically, OpenOrd groups nodes using force-directed layout and average-link clustering and iterates the grouping process to re-draw the clustered vertices until a suitable coarsened layout is reached. Then, it reverses the process to finalize the layout. With this visualization procedure, OpenOrd incorporates both local and global structure of large networks (Martin et al. 2011).

To georeference the posts to their sending locations, we used a hybrid geocoding approach. First, for a post containing a geo-tag, we used the geo-tag (a coordinate pair containing latitude and longitude) as the sending location. If a post lacked a geo-tag, we estimated the sending location based on the historical geo-tags sent by the author. If the author had no geo-tagged posts, we estimated his or her location based on the location specified in the author’s web profile. In the end, there were 184 posts with geo-tags, 16,249 posts that could be georeferenced by historical locations, and 66,189 posts that could be georeferenced by the textual locational information in the user’s web profile. Using this approach, we geocoded 83.89% of all posts to their sending locations.

Our dataset, nevertheless, is constrained by Weibo’s search algorithm—we can only take whatever Weibo provided to us—and there is limited information about how the results are filtered or censored in the process. We checked with “Freeweibo”—a watchdog website that collects censored contents on Weibo—and did not find evidence that climate change posts were censored during our study period. As our web crawlers worked continuously for the entire 2 months, we obtained popular posts even if they were later deleted due to censorship. We are confident that our dataset provides a meaningful representation of climate change dialogue on China’s cyberspace.

2 Who is speaking for the climate on Weibo?

Since some voices reach more audiences than others, the first step of our analysis was to examine who speaks out on climate issues in China's cyberspace. To find out who speaks for the climate on Weibo, we focused on the number of forwarded posts. When a user forwards a post of interest, this post appears on the user's homepage on Weibo and is visible to the user's followers. A higher forward number implies that a user's post receives more visibility among Weibo users.

Our results show that a small group of elite users generate most of the content in this discursive field. In our dataset, 42,358 users have zero forwards, meaning that their posts were not further relayed to another user. The top 1% (472 users) accounted for more than 90% of forwards, and the top 20 most visible users (Table 1) dominate more than 50% of the information people shared. Institutional users—government agencies or news media—dominate the climate change discourse on Weibo.

To some extent, climate change discourse on Weibo resembles an extension of traditional media. Half of the top 20 users were the social media arms of newspapers, magazines, and TV channels. In particular, state-owned media plays a critical role in disseminating information about climate change on the Internet—much more than in the case of air pollution. The top user, CCTV (China Central Television), is China's major state TV broadcaster; the People's Daily and the Global Times are directly published by the Chinese Communist Party. The prominence of traditional media implies that information flows from media producers to the general audience, rather than the more organic, spontaneous discussion that often characterizes American social media.

In Weibo discussions on China's air pollution, some companies take advantage of social media as a marketing platform for personal protective technologies such as air filters, masks, etc.

Table 1 Profile of the top 20 visible users

User name (Chinese)	User name and identity	User type	Forward number	PageRank
央视新闻	CCTV (China Central Television)	M (G)	19,179	0.027
这里是美国	Global Times in America	M (G)	15,274	0.013
GEM鄧紫棋	G.E.M. Gloria Tang Tsz-Kei (a Hong Kong pop star)	I	13,516	0.014
联合国	The United Nations	F	6802	0.017
新浪资讯台	SINA News	M	5594	0.022
美国驻华大使馆	U.S. Embassy in China	F	3541	0.006
环球时报	Global Times	M (G)	3409	0.01
英国那些事儿	UK Info (a Chinese blogger)	I	2951	0.01
WWF世界自然基金会	World Wildlife Fund	F	2894	0.004
新浪娱乐	SINA Entertainment	M	2790	0.008
艾力酷艾英语	Ai-Li (a well-known public speaker)	I	2378	0.01
因为她是邓皇	G.E.M. Gloria Tang Tsz-Kei fan page	I	2290	0.0003
头条新闻	SINA Top News	M	2252	0.003
天气预报	SINA Weather Channel	M	2198	0.0001
大脸撑在小胸	Li Ting (a researcher/writer)	I	2090	0.002
果壳网	Guokr (a Science Blog)	M	2045	0.004
中国日报	China Daily	M (G)	1944	0.003
美国国家地理	National Geographic	F	1939	0.005
人民日报	People's Daily	M (G)	1870	0.02
财经网	Caijing News	M	1860	0.005

I individual, *M* media, *F* foreign actors, *G* government-owned

(Kay et al. 2015). We found these commercial players to be largely absent in the conversation concerning climate change, suggesting that there are insufficient means to extract profits from individuals' responses to climate change. Some users sought to create positive brand images by associating with climate awareness campaigns or low-carbon initiatives. For example, Hong Kong pop star Gloria Tang Tsz-kei (a.k.a. G.E.M.) drew her fans' attention to the Paris Climate Summit and invited them to join the "Listen Paris 2015" event. Corporations such as L'Oreal, Unilever, and Panasonic have similar initiatives on Weibo. Nevertheless, such marketing posts were uncommon on Weibo.

On the other hand, public intellectuals (*gongzhi*) were not very visible in discussing climate change on Weibo. Among the five individual users, only Li Ting and Ai-Li are in the public intellectual category. The two accounts associated with Gloria Tang Tsz-Kei are likely managed by a commercial team rather than an individual.

We also noticed very active involvement from international actors. The United Nations, the US Embassy, the World Wildlife Fund (WWF), and National Geographic were all among the top 20 most visible users. To further investigate this phenomenon, we identified the top 15 international actors (Table 2). We also identified the top three Chinese NGOs as a reference to gauge their relative "speaking volume" on social media.

The international actors on Weibo were a diverse group. Among them, foreign governments (e.g., the US Embassy) and international organizations (e.g., the United Nations) play the most significant role in framing/affecting public opinion on climate change, based on the forward numbers. Foreign media, especially scientific content providers (e.g., Discovery Channel and National Geographic), are as visible as their Chinese counterparts. International NGOs—the WWF especially—were very active in promoting climate change awareness. Some foreign individuals also garnered distinct followings in China's cyberspace. Kevin Rudd, the Chinese-

Table 2 Top international voices and Chinese domestic NGOs

User name (Chinese)	User name and identity	User type	Forward number	PageRank
International actors				
联合国	United Nations	G	6802	0.017
美国驻华大使馆	U.S. Embassy in China	G	3541	0.006
WWF世界自然基金会	World Wildlife Fund	N	2894	0.004
美国国家地理	National Geographic	M	1939	0.005
Discovery探索频道	Discovery Channel	M	1771	0.0002
FT中文网	Financial Times	M	1197	0.0033
联合国环境规划署	United Nations Environment Programme	G	819	0.0022
华尔街日报中文网	Wall Street Journal	M	557	0.0028
欧莱雅中国	L'Oréal China	C	549	0.0032
陆克文先生	Kevin Rudd	I	339	0.0008
美国公告牌BillBoard	Billboard	C	324	0.0015
世界卫生组织	World Health Organization (WHO)	G	291	0.0005
美國駐港總領事館	Consulate General of the United States in Hong Kong and Macau	G	220	0.0001
联合国开发计划署	United Nations Development Programme	G	209	0.0004
绿色和平	Greenpeace	N	200	0.0005
Chinese NGOs				
CYCAN	China Youth Climate Action Network	N	177	0.00003
自然之友	Friends of Nature	N	101	0.0003
绿色公民行动	China Green Foundation (a.k.a. Green Citizen Action)	N	93	0.0004

I individual, *M* media, *G* government/international organizations, *C* company, *N* non-profit organizations

speaking former Australian prime minister, for example, actively engaged in policy discussions under his Chinese name (Lu Kewen). Other notable figures, such as Christine Lagarde and Leonardo Dicaprio, also discussed climate change on Weibo.

The relatively effective international actors are a stark contrast to the underrepresented Chinese domestic NGOs. The China Youth Climate Action Network (CYCAN), a coalition of young climate activists, and Friends of Nature, the largest domestic environmental NGO in China, both have forward numbers below 200. Chinese civil society’s weak voice may reflect its limited capacity in China’s political environment. The contrast may also signal different priorities: for international NGOs, climate change is the top environmental issue; for Chinese NGOs, local environmental challenges may be more urgent than climate change.

In summary, elite institutions craft key messages about climate change on China’s Internet. Based on the forward numbers, we find the discussion is led by Chinese media, especially state-owned media organizations. International players also make a significant contribution. Civil society and concerned citizens generate little content about climate change.

3 The climate change forwarding network

In addition to gauging users’ visibility through forward numbers, we analyzed the structure of the forwarding network among Weibo users, as shown in Fig. 1. In the figure, the size of nodes

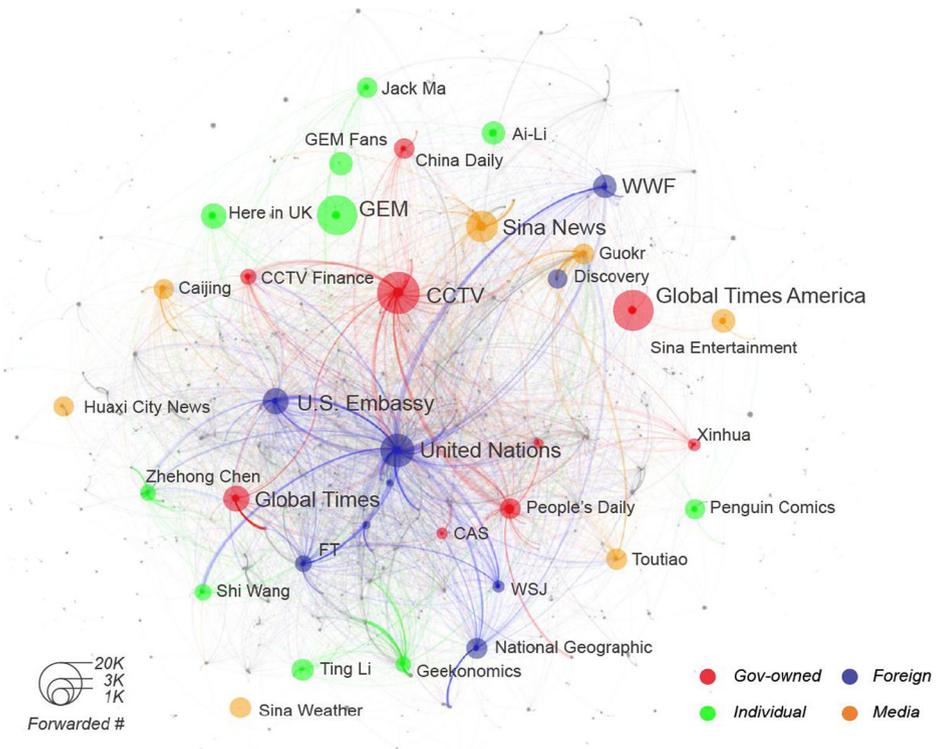


Fig. 1 Climate change forwarding network on Weibo

indicates forward numbers, while edges between nodes represent the relationship between users of forwarded posts. The darker the edge, the greater the number of exchanges.

Figure 1 should be understood alongside the PageRank values listed in Tables 1 and 2. PageRank assumes that the more important users are likely to receive more forwards from other users, and it creates a metric of the relative importance in a network on that basis.

The network analysis and PageRank reinforce our finding that climate change discussion on Chinese social media is dominated by institutional users, such as media, government entities, and international organizations. At the center of the graph, we see mostly red circles (Chinese government-owned entities) and blue circles (international actors); individual users are all on the periphery of the forwarding network. According to PageRank, the top three nodes are CCTV (China Central Television) (0.027), SINA news (0.022), and People’s Daily (0.02)—all three are media—with the United Nations trailing at fourth. Although G.E.M., the pop star, has twice as many forwards as the United Nations, her PageRank is smaller. On the other hand, the People’s Daily has a relatively low forward number, yet it is disproportionally important in the network.

4 The geography of Weibo posts

Based on the locations of all users, we also mapped the geographic space of the virtual discourses. In Fig. 2, the map on the left shows the density of users who joined the discussion, and the map on the right illustrates the density of forwarded posts. Both maps suggest that online conversations about climate change are primarily occurring in urban China and in Beijing, Shanghai, and the Pearl River Delta (the aggregate of Guangdong province, Hong Kong, and Macau) in particular. To put the maps into perspective, Beijing and Shanghai both have less than 2% of China’s population, while the Pearl River Delta has about 8%. Yet, Beijing-based users made up 11.29% of all Weibo users actively discussing climate change. Even more unevenly distributed, Beijing-based users accounted for more than half (51.74%) of the forwarded posts. In the top 200 users with geographical locations, 111 of them are based in Beijing. We concluded that much of climate change online discourse happens inside capital Beijing’s “ring roads” and then emanates to other parts of the country.

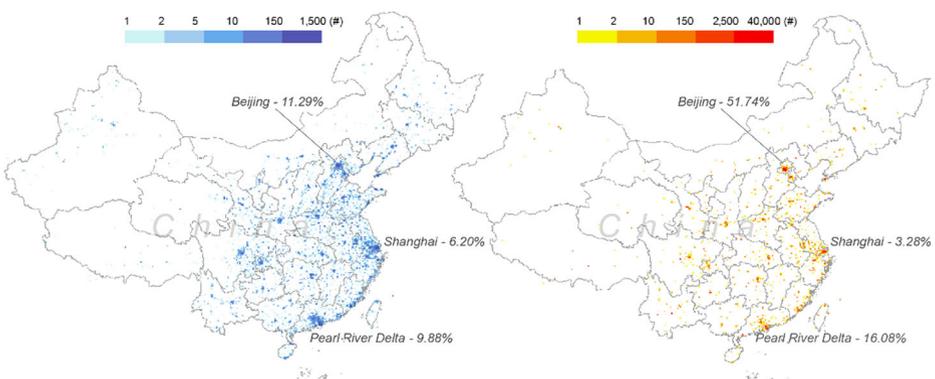


Fig. 2 The spatial distribution of Weibo users who joined the discussion (*left*) and forwarded posts (*right*)

5 Content of Weibo posts

After identifying the highly visible users, we also wanted to unpack the content of popular posts during the study period. Table 3 lists the top ten most popular climate change-related topics on Weibo. These posts comprise about 40% of the total sharing activities regarding climate change, providing a useful snapshot of the discourse surrounding climate change on Weibo.

We found that climate change mostly appears as global discourse far removed from everyday life in China. The most talked about content was President Obama's appearance on the NBC show, "Running Wild with Bear Grylls," in which he traveled with the host to Alaska to showcase the impacts of climate change. While this episode had approximately 180,000 views on Youtube as of May 2016, the same video had 1.4 million views on China's Tencent video-streaming site (v.qq.com) alone, not counting other video platforms in China. News coverage of this show in China had millions of hits. It is clear that Obama made a much larger impact in China with his trip to Alaska than in the USA. Obama also appears in another popular post, in which he exchanged thoughts about climate actions with Jack Ma Yun—the founder and CEO of China's largest e-commerce company, Alibaba Group. No widely shared Weibo post discussed climate change's potential impact on China or engaged in policy advocacy.

As our data was collected before and after the Paris Climate Summit intentionally, we found three posts related directly to the summit in our top ten content: one on President Xi Jinping's attendance, one on the Paris Agreement, and one on the city of Lanzhou winning an award. The first two were conventional news posts, but the news about Lanzhou was especially noteworthy. The award was sponsored mainly by the China Low Carbon Alliance (CLCA), a Chinese industrial association, with the UNFCCC secretariat as a co-sponsor, but in the online discourse, the story was packaged to suggest Lanzhou had received international recognition for its climate action.

Finally, we also conducted a qualitative examination on climate change skepticism in our dataset. Since no automated technique is available to detect skepticism, we read the top 1000 forwarded posts and nine of them were coded as skeptical. We further searched for keywords such as "fake" and "cheat" to trace these posts. We were able to identify two forms of skepticism.

First, there were a few moderately visible users questioning the scientific consensus on the changing climate. One such leading figure is Wan Weigang—a writer and a research associate in physics at the University of Colorado Boulder. In one of his posts, he cited (1) the lack of darkening of the Greenland ice sheet and (2) the increasing icepack in Antarctica as counter evidence to the consensus on anthropogenic climate change and continued to say that "[...]the voices promoting global warming are weakening. In two years, people will be writing books on why scientists

Table 3 The top ten most popular climate change-related topics on Weibo

Weibo post content	Forward count
President Obama appears on the show "Running Wild with Bear Grylls"	19,541
Hong Kong artist G.E.M. (Gloria Tang Tsz-kei) calls for attention to UNFCCC COP21	16,927
A photo series of "horribly thin" polar bears by German photographer Kerstin Langenberger	10,539
President Obama discusses climate change with Jack Ma Yun at the APEC summit	7870
Lanzhou wins the "Award for Today's Transformative Step 2015" at UNFCCC COP21	5787
President Xi Jinping attends the UNFCCC COP21 in Paris	5430
The Earth Hour campaign—turning off light for one hour	4373
Countries reach the Paris Agreement in UNFCCC COP21	4024
2015 might be the hottest year on record	2900
Surreal Stormchasing Portraits by photographer Benjamin Von Wong	2636

promoted global warming, and maybe in five years, the global warming theory will be cited as a joke.” This post was the only skeptical content in the top 50 forwarded posts.

The second type suggested climate change as a Western plot to exploit developing countries through carbon regulations. Here are a few examples of such posts:

“From the perspective of developed countries, climate replaces guns, cannons, and warships in old times to become the weapon to constrain, oppress, and exploit poor countries.”

“Oh, I thought this is a weather warfare used by the American imperialism?”

Our result is in line with previous research: Chinese climate skepticism is usually a function of mistrust between China and the West (Liu 2015). Although we do not have a quantitative measurement, it is clear that skeptical posts are rather fringe, based on the lower forward numbers, in the larger picture. It is best recognized as a small discursive undercurrent championed by people with a strong nationalist worldview. It is also noteworthy that the posts containing climate change skepticism were all published by individuals rather than institutional users.

6 Conclusion

While many people have high hopes for the egalitarian potential of the Internet—everyone can express their opinions behind a computer screen—in reality, whether one’s views are heard is still constrained by the larger social structure. In our study, we found that institutional users, including many state-owned media, were the main information providers on climate change. Only three out of the 20 most visible users were individual bloggers. While visibility does not equate influence per se (one can read and forward a post without being persuaded), the dominance of institutional users—and the Chinese state behind them—has strong implications for climate change communication in China.

To make sense of our results, it is instructive to contrast it with a similar study on China’s air pollution (Kay et al. 2015), which found that media players were not among the most visible users posting about air pollution on Weibo. This stark difference may reveal how the Chinese state exercises control of the media: air pollution is a potential threat to social stability, and thus reporting needs to be minimized and regulated, whereas climate change is considered relatively “safe” to report. On the other hand, public intellectuals and environmental organizations, who participated actively in talking about air pollution, contribute little to the climate change discussion. While occasionally, Chinese citizens mobilize on social media to engage in contentious environmental actions, climate change is not such a field. We do not expect that events like the “People’s Climate March” will happen in China.

State control affects *who* gets to speak, as well as *what* is being said on climate change in China. Climate change remains “safe” as long as it appears to be a global and disembodied subject matter. The content we captured thus mostly treats climate change as entertainment (G.E.M. and President Obama’s reality show) or as distant international news (Paris Climate Summit). No popular posts dealt with climate change’s impact on China or policy advocacy at the central or local government level. Although the international actors played a significant role in channeling climate change information, they mainly engaged in apolitical awareness campaigns (e.g., WWF’s Earth Hour) without challenging the Chinese state.

Where does our result lead us regarding communicating climate change in China? Surveys show that the Chinese public is aware of climate change and favors action, yet climate change remains low in policy priorities and far out of sight for most Chinese people (Liu and

Leiserowitz 2009; Yale Project on Climate Change Communication 2012; Stokes et al. 2015). Our results show that climate change seems distant and decontextualized on Weibo. Climate communicators can potentially make progress by relating the global threat to China's domestic concerns and subsequently crafting more localized messages; at the same time, they need to stay within the safe zone of allowed political discourse.

References

- Auer MR, Zhang Y, Lee P (2014) The potential of microblogs for the study of public perceptions of climate change. *WIREs-Clim Chang* 5:291–296
- Cody EM, Reagan AJ, Mitchell L, Dodds PS, Danforth CM et al (2015) Climate change sentiment on Twitter: an unsolicited public opinion poll. *PLoS One* 10, e0136092
- Farrell J (2016a) Corporate funding and ideological polarization about climate change. *Proc Natl Acad Sci U S A* 113:92–97
- Farrell J (2016b) Network structure and influence of the climate change countermovement. *Nat Clim Chang* 6:370–374
- Fedorenko I, Sun Y (2015) Microblogging-based civic participation on environment in China: a case study of the PM 2.5 campaign. *VOLUNTAS* 1–29
- Jacques PJ, Dunlap RE, Freeman M (2008) The organisation of denial: conservative think tanks and environmental scepticism. *Environ Polit* 17:349–385
- Jasny L, Waggle J, Fisher DR (2015) An empirical examination of echo chambers in US climate policy networks. *Nat Clim Chang* 5:782–786
- Kay S, Zhao B, Sui D (2015) Can social media clear the air? A case study of the air pollution problem in Chinese cities. *Prof Geogr* 67:351–363
- Kirilenko AP, Stepchenkova SO (2014) Public microblogging on climate change: one year of Twitter worldwide. *Glob Environ Chang* 26:171–182
- Koteyko N, Nerlich B, Hellsten I (2015) Climate change communication and the Internet: challenges and opportunities for research. *Environ Commun* 9:149152
- Liu JC-E (2015) Low carbon plot: climate change skepticism with Chinese characteristics. *Environ Sociol* 1:280–292
- Liu JC-E, Leiserowitz AA (2009) From red to green? Environmental attitudes and behavior in urban China. *Environment* 51:32–45
- Martin S, Brown WM, Klavans R, Boyack KW (2011) OpenOrd: an open-source toolbox for large graph layout. In *IS&T/SPIE Electronic Imaging*. International Society for Optics and Photonics
- Newman TP (2016) Tracking the release of IPCC AR5 on Twitter: users, comments, and sources following the release of the Working Group I Summary for Policymakers. *Public Underst Sci* 1:11
- O'Neill S, Williams HT, Kurz T, Wiersma B, Boykoff M (2015) Dominant frames in legacy and social media coverage of the IPCC Fifth Assessment Report. *Nat Clim Chang* 5:380–385
- Pearce W, Holmberg K, Hellsten I, Nerlich B (2014) Climate change on Twitter: topics, communities and conversations about the 2013 IPCC Working Group I report. *PLoS One* 9, e94785
- Pearce W, Brown B, Nerlich B, Koteyko N (2015) Communicating climate change: conduits, content, and consensus. *WIREs-Clim Chang* 6:613–626
- Schafer MS (2012) Online communication on climate change and climate politics: a literature review. *WIREs-Clim Chang* 3:527–543
- Seegerberg A, Bennett WL (2011) Social media and the organization of collective action: using Twitter to explore the ecologies of two climate change protests. *Commun Rev* 14:197–215
- Sina Weibo Data Center (2015) Weibo user development report 2015 (in Chinese) <http://data.weibo.com/report/reportDetail?id=297>
- Stokes B, Wike R, Carle J (2015) Global concern about climate change, broad support for limiting emissions. Pew Research Center
- Sullivan J, Xie L (2009) Environmental activism, social networks and the internet. *China Q* 198:422–432
- Veltri GA, Atanasova D (2015) Climate change on Twitter: content, media ecology and information sharing behaviour. *Public Underst Sci*. doi:10.1177/0963662515613702
- Williams HT, McMurray JR, Kurz T, Lambert FH (2015) Network analysis reveals open forums and echo chambers in social media discussions of climate change. *Glob Environ Chang* 32:126–138
- Yale Project on Climate Change Communication (2012) Public climate change awareness and climate change communication in China
- Yang G, Calhoun C (2007) Media, civil society, and the rise of a green public sphere in China. *China Inf* 21:211–236