Climate Policy Elites' Twitter Interactions across Nine Countries*

Ted Hsuan Yun Chen[†,1] Arttu Malkamäki[†,2] Ali Faqeeh[2]
Esa Palosaari[2] Anniina Kotkaniemi[3] Laura Funke[4] Cáit Gleeson[5]
James Goodman[6] Antti Gronow[3] Marlene Kammerer[7]
Myanna Lahsen[8] Alexandre Marques[8] Petr Ocelik[9] Shivangi Seth[10]
Mark Stoddart[4] Martin Svozil[11] Pradip Swarnakar[12] Matthew Trull[6]
Paul Wagner[11] Yixi Yang[4] Mikko Kivelä[2] Tuomas Ylä-Anttila[3]

December 14, 2024

Abstract

We identified the Twitter accounts of 941 climate change policy actors across nine countries, and collected their activities from 2017–2022, totalling 48 million activities from 17,700 accounts at different organizational levels. There is considerable temporal and cross-national variation in how prominent climate-related activities were, but all national policy systems generally responded to climate-related events, such as climate protests, in a similar manner. Examining patterns of interaction within and across countries, we find that these national policy systems rarely directly interact with one another, but are connected through consistently engaging with the same content produced by accounts of international organizations, climate activists, and researchers.

Keywords: policy networks, climate change, polycentric governance, social media affordances, transnational organization

*Corresponding authors: Ted Hsuan Yun Chen (ted.hsuanyun.chen@gmail.com), Arttu Malkamäki (arttu.1.malkamaki@aalto.fi), and Tuomas Ylä-Anttila (tuomas.yla-anttila@helsinki.fi). This work is funded by Academy of Finland grants 320780 and 320781. We thank Aasa Karimo, Otto Schultz, and Amirmohammad Ziaei Bideh for providing invaluable research assistance. We acknowledge the computational resources provided by the Aalto Science-IT project. Our data collection protocol and its code implementation can be found at `github.com/tedhchen/componMultilayer`.

[†]Equal contribution alphabetically ordered by surname for the version of record. Both authors are free to list themselves as first author in personal publication lists.

[1]Department of Environmental Science and Policy, George Mason University, USA
[2]Department of Computer Science, Aalto University, Finland
[3]Faculty of Social Sciences, University of Helsinki, Finland
[4]Memorial University of Newfoundland, Canada
[5]Dublin City University, Ireland
[6]University of Technology Sydney, Australia
[7]University of Bern, Switzerland
[8]The National Institute for Space Research (INPE), Brazil
[9]Masaryk University, Czech Republic
[10]Indian Institute of Technology Kanpur, India
[11]Edinburgh Napier University, United Kingdom

Contents

1 Introduction

Social media is an important space for interactions between climate policy actors (Dellmuth and Shyrokykh 2023; Kavada and Specht 2022), with a burgeoning literature recognizing them as critical platforms of political contestation and democratic participation (Robertson et al. 2019; Theocharis 2015). Many organizations and individuals key to climate policy actively participate on social media platforms (e.g., UNFCCC, Greta Thunberg), using them to engage with the public and with one another. Twitter (now X), in particular, is among the most important social media platforms (at least until Elon Musk's takeover in 2022) where policy actors and other political elites engage in various aspects of the policy process (Conway, Kenski and Wang 2015; Ausserhofer and Maireder 2013), such as setting agendas and discourse (Gilardi et al. 2022), vying for political support (McGregor, Mourão and Molyneux 2017), and mobilizing movements (Segerberg and Bennett 2011).

There is an extensive literature on climate politics and climate policy debates on Twitter (Fownes, Yu and Margolin 2018), but researchers have yet to explicitly consider Twitter or other social media platforms through the lenses of the policy and governance literatures (Ostrom 2010; Atkinson and Coleman 1992), specifically, as sociotechnical policy systems where policy elites collaborate and compete to influence the climate policy process while operating under the platforms' affordances and constraints (Dellmuth and Shyrokykh 2023).

First, studies usually do not focus on the policy *system*, often missing important components of the policy contestation process (Cairney 2012). They either do not disaggregate policy actors from the general public, looking instead at general trends in climate communication or opinion dynamics (Falkenberg et al. 2022; Chen et al. 2021; Cody et al. 2015), or only examine an incomplete subset of climate policy actors, focusing on specific types[1] or using system bounding rules that exclude actors based on how active or popular they are (Goritz et al. 2022; Stier, Schünemann and Steiger 2018).

Second, studies rarely consider the policy system's *sociotechnical* qualities despite the importance of contextual effects to how policy actors interact (Metz and Brandenberger 2023). From the technology affordances literature (Evans et al. 2017), we know that social media platforms have distinct affordances – perceived or understood properties of the technology that enable and constrain action – that shape the nature of social interactions (Ronzhyn, Cardenal and Batlle Rubio 2023). With recent studies showing that online and offline policy spaces follow different organizing principles, manifesting in observable differences in policy process interactions and outcomes (Kotkaniemi, Ylä-Anttila and Chen 2024; Malkamäki

[1] Such as politicians (Ebrey, Hall and Willis 2020; Ghoraba 2023), non-governmental organizations (Hart et al. 2024; Vu et al. 2020), and scientists (Walter, Lörcher and Brüggemann 2019).

et al. 2023; Hayes and Scott 2018), can we examine the affordances that are activated in the Twitter climate policy system to see how they shape the policy process?

Among different social media affordances (Ronzhyn, Cardenal and Batlle Rubio 2023), we focus on the potential for blurred boundaries between personal and professional lives on social media (Siegert and Löwstedt 2019), which introduces both substantive and methodological implications for how we understand this policy system. Policy actors are often organizational, comprising various subunits and employees or members, all likely holding different preferences and understandings of their organizations' goals and coordination modes (Meglino and Ravlin 1998; Van de Ven, Delbecq and Koenig Jr 1976). Because social media are populated by accounts with clearly-indicated professional affiliations that are at the same time for personal use (Ford 2011), the existence of within-organization variation raises the critically under-explored question about how we conceptualize policy *actors* and policy contestation on social media.

Despite this, studies of policy actors on social media overwhelmingly focus on only the official account of organizations, leaving the entirety of policy actions undertaken by organizations' executives and rank-and-file members unexamined. With this in mind, we focus our examination on the disaggregation of policy actors on social media and how systematic variation across organizational levels plays into the organizing principle of this policy space. For example, while these non-official accounts heighten the visibility of the organizations they belong to, they also behave differently from these organizations' official accounts, including how they align with other policy actors on social media, which calls into question organizational policy actors' messaging coherence (Palosaari et al. 2024).

In highlighting these platformed affordances, we directly engage with the policy and governance literatures by explicitly bringing the concept of polycentric governance to social media policy research. Seminal studies have clearly demonstrated that governance systems are best considered as polycentric, comprising policy actors operating across different levels and forming different loci of authority (Ostrom 2010). By examining Twitter accounts from different levels of climate policy organizations, we springboard from this notion and show that the complex nature of multiscalar policy behavior does not stop at the boundaries of organizational entities. Here, we explore the tension between the flatness of Twitter as a social media platform and the oft-observed existence of social hierarchies in interactional and communicative behaviors (Kotkaniemi, Ylä-Anttila and Chen 2024; Dagoula 2019). Again, this links back to the importance of understanding social media affordances and their relationship to policy organizations (Behrend, Ravid and Thapa 2024), as the highly visible and persistent nature of social media platforms (Neubaum 2022; Ramirez 2018), which allows for contemporaneous and archival monitoring, potentially makes hierarchical organizational

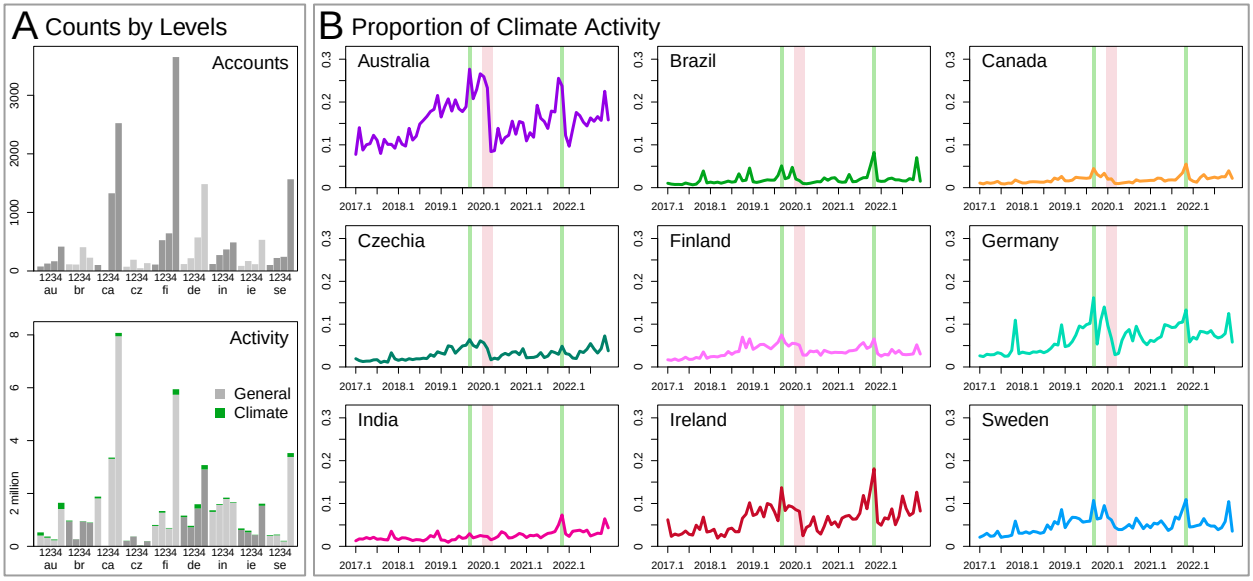

Figure 1: Overview of our data. Panel A) Numbers of accounts and activity by country and organization level. Panel B) Monthly ratio of climate activity to total activity. The first green bar marks the Fridays for Future strikes in September 2019, and the second green bar marks COP26 in November 2021. The red bar covers January–March 2020, which is the onset of the COVID-19 pandemic.

constraints more salient despite the technically flat platform.

To conduct our exploration, we identified the relevant Twitter accounts for 941 climate policy actors across nine countries – Australia, Brazil, Canada, Czechia, Finland, Germany, India, Ireland, Sweden. These policy actors – including government ministries, NGOs, businesses, and research institutes – were identified by local experts, and represented the most important organizational entities in each country's climate policy system (Ylä-Anttila et al. 2018). For each policy organization, we identified 1) their primary Twitter account, 2) the accounts of their top-level executives, 3) the accounts associated with their organizational subunits or specific functions, and 4) the accounts of their rank-and-file members. Then we collected the Twitter activities of all these accounts from 2017–2022, totalling to 48 million activities across 17,700 accounts. In the first iteration of our paper, we conducted exploratory analysis on how these accounts interacted with one another within and across the boundaries of their national policy systems. We discuss planned analysis at the end of our manuscript.

2 Results

2.1 System Size and Activity Levels

As shown in Figure 1 (Panel A), there is considerable variation in the number of identified accounts and their total activity across countries and organization levels. Naturally, based on

our definition of the four different organization levels, we identified many more organizational subunits and rank-and-file members or employees than we did organization's executives. Interestingly, this distribution did not fully translate to activity counts. While rank-and-file members are collectively the most active simply due to their numbers, organizations' primary accounts tend to be just as active, if not more, when compared to the activity levels of executive and organizational subunits.

Of our total 48 million activities, 2 million (or 4.2%) are climate change-related based on a relatively strict dictionary-based classification (see Section 4.3.1). As shown in Figure 1 (Panel B), the proportion of climate tweets to general tweets, which captures the relative importance and salience of the climate change issue, varied greatly both by country and across time. For example, in September 2019 (marked with the first green bar), which was the time of the Fridays for Future climate strikes, the Australian policy system had 28% of climate-related activity, the highest observed proportion in our data set. The cross-national variation suggests that climate policy organizations had different levels of specialization across different national policy systems, and the temporal variation means that climate policy communication on Twitter responds to broader societal factors.

Indeed, while the ratio of climate activity to overall activity varied across each national system, the temporal variation in general and climate Twitter activity exhibits a number of interesting similarities and is generally comparable across systems. This indicates that they are responsive to a similar set of events. For example, we see climate activity peaks during the 2019 Fridays for Future climate strikes and during COP26 in November 2021. Most notably, climate activity was subject to a COVID dip, whereby the world's focus on COVID-19 shifted attention away from climate change (Smirnov and Hsieh 2022).

2.2 Interactions within and across countries

To understand the extent to which climate policy actors engage with one another across policy systems, we examined different types of interactions between accounts. First, we looked at direct connections, which we measured using direct retweeting. Second, we looked at indirect connections, which we measured as joint retweets of a third-party tweet.

2.2.1 Direct Engagement

Figure 2 shows the annual climate change retweet network. It is immediately apparent how isolated each national policy system is from one another, with some minor exceptions. Figure 3 shows different types of mixing matrices pooled across time. Panel A clearly reflects the network plots, with the Australian and Irish systems most densely connected, and all national systems much more densely connected internally than across systems. In Panel B,

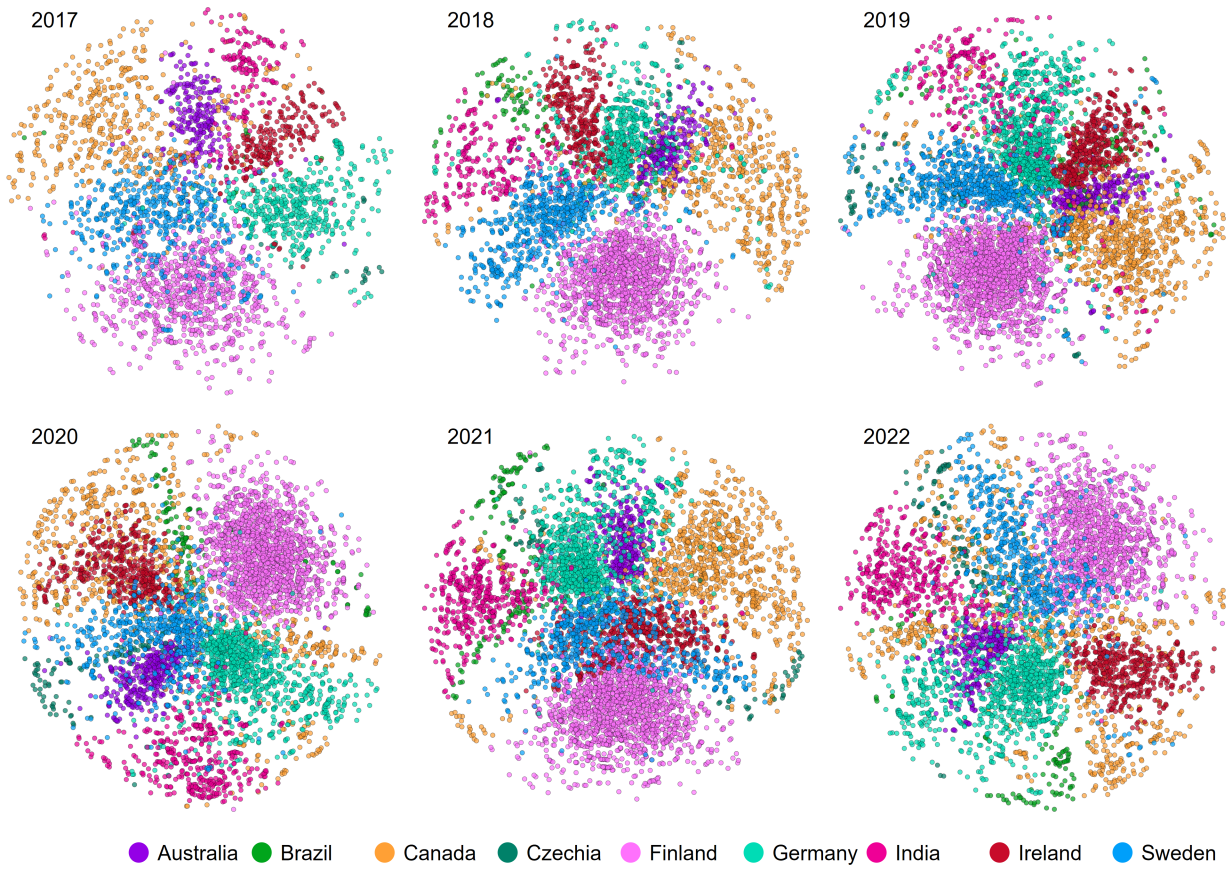

Figure 2: Climate change retweet networks, 2017–2022. Nodes are placed using the Fruchterman-Reingold algorithm and edges are not plotted for visual clarity. Only the largest weakly connected component is shown.

we rescale the relative density to within each national policy system, which shows a number of similarities across countries. First, policy actors' primary organization accounts tend to be more connected to one another, and also tend to be both more active in retweeting and more popularly retweeted. Next, in Panel C, we examine the cross-country connections by themselves. We find that Germany and Sweden tend to be active in retweeting across the boundaries of their national policy systems, with Swedish executive accounts being the most active. These cross-country patterns are also clearly driven by regional ties, such as the considerably higher amount of reciprocity between Swedish and Finnish accounts.

2.2.2 Indirect Engagement

Next, we consider indirect connections between policy actors. We measure this by considering instances of accounts jointly retweeting the same tweet made by an account not on our policy actor roster. Regardless of whether these joint retweets are the result of direct information diffusion, they indicate similar preferences among connected accounts (i.e., because they endorsed the same content) and similar resulting information diffusion (i.e., the same external

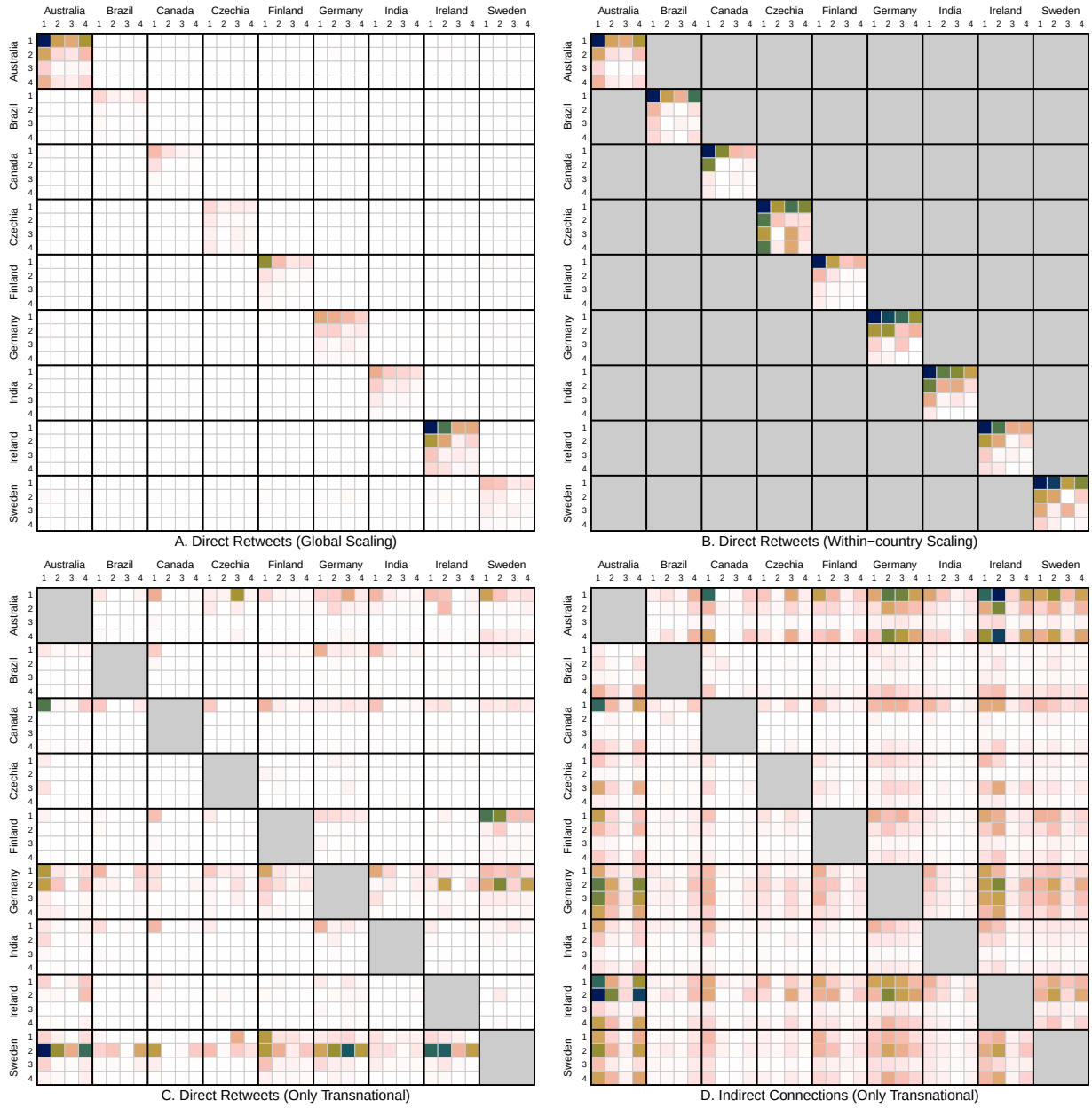

Figure 3: Mixing matrices for direct (retweets) and indirect (joint retweeting) connections. Cells are the mean logged (e) counts of connections (with min-max scaling) between all pairs of accounts with the given country-level combinations. Darker cells indicate higher connectedness. Axes labels refer to 1) organization primary, 2) individual executive, 3) organization auxiliary, and 4) individual non-executive accounts.

information was shared into the actors' networks). Here, relative to direct retweets, Australia is the most connected, followed by Germany and Ireland. Geographical and cultural factors ostensibly plays a role here, as India and Brazil have the least connected systems.

To better understand these indirect connections across countries, we examine the bridging actors, or accounts whose tweets are most jointly retweeted by accounts from different countries. For each tweet, we calculated its bridging statistic, which is the number of times

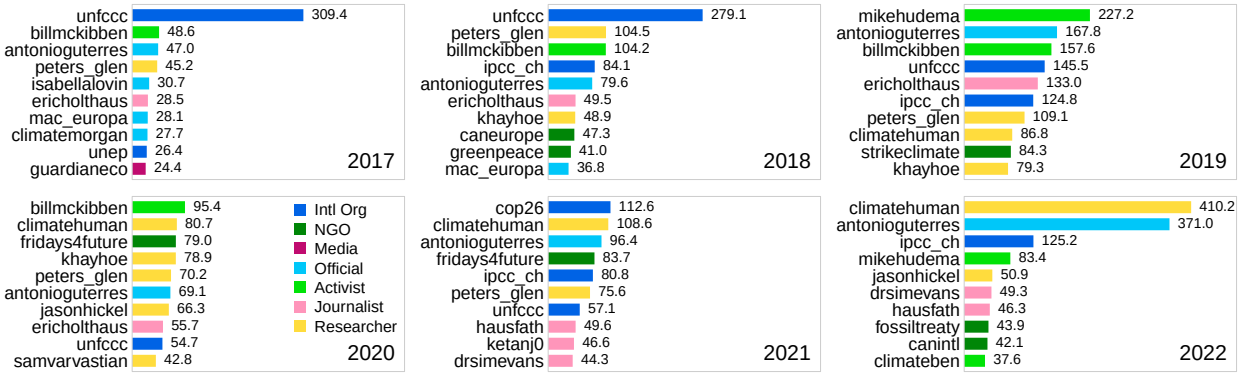

Figure 4: Top ten bridging accounts by year. The bridging statistic is the sum of the logged (e) retweet counts across all retweeted tweets from the account in the given year.

the tweet was retweeted by pairs of accounts from different countries. To prioritize accounts that consistently bridge at a high volume, as opposed to those that had a single tweet become massively viral, we took the natural log of all tweets' bridging statistics then summed them to the account level.[2] As shown in Figure 4, these bridging actors tend to be the accounts of international organizations, including senior officials from these agencies, and individual climate activists. Interestingly, during 2020, scientists were overwhelmingly represented in the list of top bridging actors.

3 Future Work

In the current study, we have shown a set of descriptive statistics about the nine national climate policy systems that is part of a larger transnational climate policy system on Twitter. In future iterations of this study, we will expand our analysis both in terms of conducting deeper analysis into policy actors' behaviors and interactions, and in terms of considering a broader set of observable behaviors.

First, while we have shown general interaction patterns, we have not statistically examined the generative features of these relational systems. We will statistically model the structure of their interaction networks based on which national policy system they belong to, their sectors, and the specific organizational level of each account. Second, while we have primarily looked at retweeting patterns, they only constitute a portion of interactions between policy actors on Twitter. We will extend our analysis to include other interactions such as direct responses to each other or directly linking to each other's tweets. Third, in terms of analyzing the bridging actors, showing the strongest bridging actors is only part of the picture, as it misses other individuals and organizations ostensibly important to climate

[2] $\sum_{t \in T} \ln(\text{bridging}_t)$, where t is a single tweet out of all the account's tweets T.

policy Twitter but do not bridge national policy systems. Finally, we will also examine the textual content of the tweets to understand whether the literal text is used semantically differently across different contexts and by different users (Rodriguez, Spirling and Stewart 2023).

4 Methods and Data

4.1 Identifying Climate Policy Elites in National Policy Systems

We collected the roster of relevant policy elites of each country's climate policy system as part of the Comparing Climate Change Policy Networks project (Ylä-Anttila et al. 2018). For each country, a team of local researchers identified 50–100 of the most influential organizations in the field of climate change policy based on the team's local knowledge of the case, media appearances of the organizations, and consultations with local climate policy experts. These organizations are policy actors with an interest in influencing climate policy, and have employees or members who specialize in climate policy issues. These organizations represent different sectors of societal actors, including governmental actors, political parties, NGOs, businesses, and science actors, and can be considered as representing the climate policy elite in each of the countries.

4.2 Identifying Policy Organizations and Members on Twitter

For each policy actor, we identified four "levels" of organizational roles: 1) organization primary, 2) individual executive, 3) organizational auxiliary, and 4) individual non-executive. These levels are summarized in Table 1, using WWF-Australia as an example. Here, we describe the conceptual bounds of each organizational level, and describe how we identified each of these subsets of accounts. A schema of our protocol is shown in Figure 5.[3]

Organization Primary This is the primary organizational account of the policy actor. There is only one account in this category for each organization. This account can be manually identified in a number of ways, including from the organization's website, from a Twitter search, or from a general web search.

Individual Executive This level includes the executive personnel of the organization. We consider these as individuals with decision-making power for the entire organization. This

[3] Additional details of our account identification and data collection protocols can be found in our codebook at the following Github repository (`github.com/tedhchen/componMultilayer`).

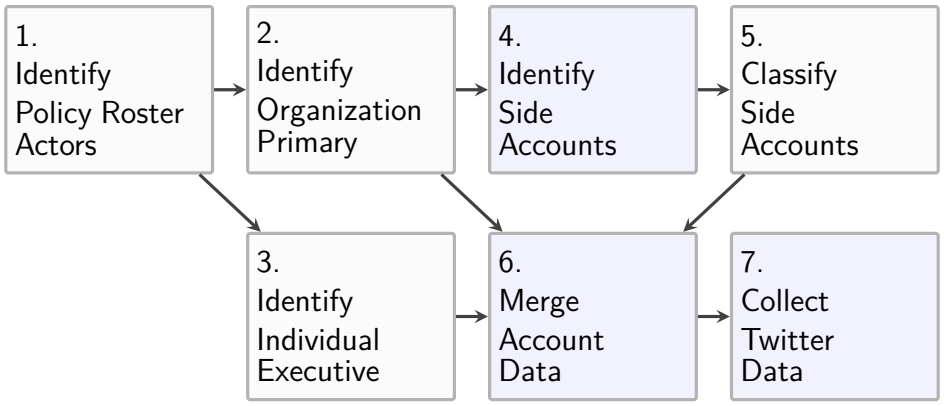

Figure 5: Data collection protocol. Gray tasks are fully manual and blue tasks are computer-assisted.

specifically means that we want to collect leaders of the top-level unit in the organization (i.e., before organizational subunits become parallel). Leaders of lower-level parallel subunits should not be included. For example, in a business organization, these accounts would be for members of the top level executive management team.

Individual executive accounts can be manually identified in a number of ways, including from the organization's website, from a Twitter or Linkedin search, or a general web search.

Organization Auxiliary This level includes the accounts of organizational subunits or accounts used for the organization's focused functions. Because we have a high number of policy actor organizations, we have developed a Twitter-specific protocol to collect this data. Specifically, we only include Twitter accounts that satisfy all of the following criteria:

1. Follows the organization's primary Twitter account
2. Is followed by the organization's primary Twitter account
3. Has at least one of the organization's pre-specified keywords in its Twitter bio; these

Level	Description	Example
Organization Primary	Primary organizational account of the policy actor.	`@wwf_australia`
Individual Executive	Accounts of the organization's executive personnel. This level includes only the top-level executive and the chair of the board of directors.	`@rachlowry` (Chief Conservation Officer)
Organization Auxiliary	Accounts of organization's subunits or accounts used for focused functions of the organization.	`@rewildingoz` (Rewilding Program)
Individual Non-executive	Accounts of the organization's personnel who are not members of the top-level executive.	`@darrengroverwwf` (Head of Healthy Land and Seascapes)

Table 1: Overview of different organizational levels. Examples are from WWF-Australia.

organization-specific keywords are specified by country experts, and usually include at least different variations of the organization's name
4. Twitter bio passes manual filtering

Tasks 1–3 are computer assisted. For each organization's primary account, we used Twitter's API to collect the list of accounts it followed and the list of accounts that followed it. Then, we collected the Twitter bios of accounts satisfying both conditions to match against the organization's keywords. Finally, the remaining accounts are manually checked by a country expert.

Individual Non-executive This level includes all identifiable individuals that work or are members of the organization and have not already been identified as an organization executive. Again, because this is a difficult category to identify, we used the same criteria as the ones we used for identifying organization auxiliary accounts. In the manual filtering stage, accounts that have already been identified as an individual executive account are naturally excluded.

Depending on the type of organization, drawing the line between the executives and non-executives can be difficult. Some organizations have a relatively flat structure without a clear leader or executive team (e.g., social movement organizations like Extinction Rebellion). In such cases, we labelled all their representatives as executive personnel.

4.3 Data Collection and Preprocessing

After identifying the complete roster of accounts, we collected, for each account, all Twitter activity (or 'statuses') for January 1, 2017–December 31, 2022. This included all original tweets with or without mentions of other accounts, all replies to other tweets, and all retweets. We did not collect data on 'likes'. We collected the data using the `statuses/filter` endpoint from Twitter's V1.1 API suite, specifically matching by the users' ID or username. Data collection took place at several different time points during December 2021–February 2023. Across the nine countries, we collected a total of 47.7 million statuses.

4.3.1 Subsetting to Climate Change Statuses

To extract Twitter statuses related to climate change, we used a dictionary-based approach, which matched statuses against a set of climate-relevant keywords. This returned approximately 2 million matches, making up 4.2% of our total statuses. Our dictionary contained English and, where relevant for specific countries, the language most commonly spoken or used by policy actors in that national policy system. Specifically, our dictionary included

also Czech (Czechia), Finnish (Finland), French (Canada), German (Germany), Hindi (India), Portuguese (Brazil), and Swedish (Sweden). These keywords are shown in Table 2 and Figure 6.

Before conducting exact matching with our keyword lists, we preprocessed our text data in the following ways. First, we ignored letter casing to account for usage of capital letters in the start of the sentences, in hashtags, and for emphasis. Second, we removed URLs to eliminate false positives for short keywords such as "CO2". Third, we lemmatized the tweet text using language-appropriate libraries,[4] which lets us reduce false negatives that result from different possible forms of keywords (e.g., "emission" versus "emissions").

[4]We used `spaCy` (https://spacy.io/usage/models) because of its high reported accuracy measures for all languages except for Czech (which was absent from the library) and Hindi (for which lemmatization was not reliable). For Czech, we used `Simplemma` (https://pypi.org/project/simplemma), which we investigated and verified its reliable performance on a sample of tweets. For Hindi, we left the text unlemmatized.

English	Finnish	Swedish	German	Czech	Portuguese	French
COP23	COP23	cop23	COP23	COP23	COP23	COP23
COP24	COP24	COP24	COP24	COP24	COP24	COP24
COP25	COP25	COP25	COP25	COP25	COP25	COP25
COP26	COP26	COP26	COP26	COP26	COP26	COP26
COP27	COP27	COP27	COP27	COP27	COP27	COP27
IPCC	IPCC	IPCC	IPCC	IPCC	IPCC	IPCC
UNFCCC	UNFCCC	UNFCCC	UNFCCC	UNFCCC	UNFCCC	UNCCCC
climate	ilmasto	klimat	klima	klima	clima	climat
global warming	maapallon lämpeneminen	Global uppvärmning	globale Erwärmung	globální oteplování	aquecimento global	réchauffement climatique
greenhouse	kasvihuone	växthus	Gewächshaus	skleník	estufa	serre
CO2	CO2	CO2	CO2	CO2	CO2	CO2
emission	päästö	utsläpp	Emission	emise	emissão	émission
fossil	fossiili	fossil	Fossil	fosilní	fóssil	fossile
carbon	hiili	kol	Kohlenstoff	uhlík	carbono	carbone
coal	hiili	kol	kohle	uhlí	carvão	charbon
greenhouse gas	kasvihuonekaasu	växthusgas	treibhausgas	skleníkový plyn	gás de efeito estufa	gaz à effet de serre

Table 2: Sets of keywords used for each language, excluding the words used to match to the Hindi which are included in Fig. 6.

Hindi	English
जलवायु	Climate
ग्लोबल वार्मिंग	Global warming
ग्रीन हाउस	Greenhouse
उत्सर्जन	Emission
जीवाश्म	Fossil
कार्बन	Carbon
कोयला	Coal
ग्रीन हाउस गैस	Green house gas
ग्रीनहाउस	Greenhouse
ग्रीनहाउस गैस	Greenhouse gas
फ़ॉसिल	Fossil
एमिशन	Emission

Figure 6: Hindi Keywords and their translation excluding the other English words that also used for tweets in Hindi language. This is loaded as a figure to avoid possible rendering errors for Hindi fonts in generating the PDF version of this paper.

CRediT Author Statement

Ted Hsuan Yun Chen: Conceptualization, Methodology, Software, Validation, Formal analysis, Investigation, Data Curation, Writing - Original Draft, Visualization, Supervision. **Arttu Malkamäki:** Conceptualization, Methodology, Software, Validation, Investigation, Data Curation, Writing - Original Draft, Supervision. **Ali Faqeeh:** Conceptualization, Software, Validation, Formal analysis, Investigation, Writing - Original Draft. **Esa Palosaari:** Conceptualization, Validation, Investigation, Data Curation. **Anniina Kotkaniemi:** Conceptualization, Validation, Investigation, Data Curation. **Laura Funke:** Data Curation. **Cáit Gleeson:** Data Curation. **James Goodman:** Validation, Resources, Data Curation. **Antti Gronow:** Conceptualization, Validation, Data Curation, Writing - Review & Editing, Resources. **Marlene Kammerer:** Validation, Resources, Data Curation. **Myanna Lahsen:** Validation, Resources, Data Curation. **Alexandre Marques:** Data Curation. **Petr Ocelik:** Validation, Data Curation, Resources. **Shivangi Seth:** Validation, Data Curation. **Mark Stoddart:** Validation, Resources, Data Curation. **Martin Svozil:** Validation, Data Curation. **Pradip Swarnakar:** Validation, Resources, Data Curation. **Matthew Trull:** Data Curation. **Paul Wagner:** Validation, Resources, Data Curation. **Yixi Yang:** Validation, Data Curation. **Mikko Kivelä:** Conceptualization, Validation, Resources, Writing - Review & Editing, Supervision, Project administration, Funding acquisition. **Tuomas Ylä-Anttila:** Conceptualization, Validation, Resources, Data Curation, Writing - Review & Editing, Supervision, Project administration, Funding acquisition.

References

Atkinson, Michael M and William D Coleman. 1992. "Policy networks, policy communities and the problems of governance." *Governance* 5(2):154–180.

Ausserhofer, Julian and Axel Maireder. 2013. "National politics on Twitter: Structures and topics of a networked public sphere." *Information, communication & society* 16(3):291–314.

Behrend, Tara S, Daniel M Ravid and Stuti Thapa. 2024. "Implications of Social Media for a Changing Work Landscape." *Annual review of organizational psychology and organizational behavior* 11(1):337–361.

Cairney, Paul. 2012. "Complexity theory in political science and public policy." *Political studies review* 10(3):346–358.

Chen, Ted Hsuan Yun, Ali Salloum, Antti Gronow, Tuomas Ylä-Anttila and Mikko Kivelä. 2021. "Polarization of climate politics results from partisan sorting: Evidence from Finnish Twittersphere." *Global Environmental Change* 71:102348.

Cody, Emily M, Andrew J Reagan, Lewis Mitchell, Peter Sheridan Dodds and Christopher M Danforth. 2015. "Climate change sentiment on Twitter: An unsolicited public opinion poll." *PloS one* 10(8):e0136092.

Conway, Bethany A, Kate Kenski and Di Wang. 2015. "The rise of Twitter in the political campaign: Searching for intermedia agenda-setting effects in the presidential primary." *Journal of computer-mediated communication* 20(4):363–380.

Dagoula, Chrysi. 2019. "Mapping political discussions on Twitter: Where the elites remain elites." *Media and Communication* 7(1):225–234.

Dellmuth, Lisa and Karina Shyrokykh. 2023. "Climate change on Twitter: Implications for climate governance research." *Wiley Interdisciplinary Reviews: Climate Change* 14(6):e848.

Ebrey, Rhian, Stephen Hall and Rebecca Willis. 2020. "Is Twitter Indicating a Change in MP's Views on Climate Change?" *Sustainability* 12(24):10334.

Evans, Sandra K, Katy E Pearce, Jessica Vitak and Jeffrey W Treem. 2017. "Explicating affordances: A conceptual framework for understanding affordances in communication research." *Journal of computer-mediated communication* 22(1):35–52.

Falkenberg, Max, Alessandro Galeazzi, Maddalena Torricelli, Niccolò Di Marco, Francesca Larosa, Madalina Sas, Amin Mekacher, Warren Pearce, Fabiana Zollo, Walter Quattrociocchi et al. 2022. "Growing polarization around climate change on social media." *Nature Climate Change* 12(12):1114–1121.

Ford, Sarah Michele. 2011. "Reconceptualizing the public/private distinction in the age of information technology." *Information, Communication & Society* 14(4):550–567.

Fownes, Jennifer R, Chao Yu and Drew B Margolin. 2018. "Twitter and climate change." *Sociology Compass* 12(6):e12587.

Ghoraba, Mai Osama. 2023. "Influential Spanish Politicians' Discourse of Climate Change on Twitter: A Corpus-Assisted Discourse Study." *Corpus Pragmatics* 7(3):181–240.

Gilardi, Fabrizio, Theresa Gessler, Maël Kubli and Stefan Müller. 2022. "Social media and political agenda setting." *Political communication* 39(1):39–60.

Goritz, Alexandra, Johannes Schuster, Helge Jörgens and Nina Kolleck. 2022. "International public administrations on Twitter: A comparison of digital authority in global climate policy." *Journal of Comparative Policy Analysis: Research and Practice* 24(3):271–295.

Hart, Sol P., Lauren Feldman, Soobin Choi, Sedona Chinn and Dan Hiaeshutter-Rice. 2024. "Climate change advocacy and engagement on social media." *Science Communication* 00(0):1–28.

Hayes, Adam L and Tyler A Scott. 2018. "Multiplex network analysis for complex governance systems using surveys and online behavior." *Policy Studies Journal* 46(2):327–353.

Kavada, Anastasia and Doug Specht. 2022. Environmental Movements and Digital Media. In *The Routledge Handbook of Environmental Movements*, ed. Maria Grasso and Marco Giugni. Routledge chapter 35, pp. 538–551.

Kotkaniemi, Anniina, Tuomas Ylä-Anttila and Ted Hsuan Yun Chen. 2024. "Policy influence and influencers online and off." *Policy Studies Journal* 52(2):349–367.

Malkamäki, Arttu, Ted Hsuan Yun Chen, Antti Gronow, Mikko Kivelä, Juho Vesa and Tuomas Ylä-Anttila. 2023. "Complex coalitions: political alliances across relational contexts." *arXiv preprint arXiv:2308.14422* .

McGregor, Shannon C, Rachel R Mourão and Logan Molyneux. 2017. "Twitter as a tool for and object of political and electoral activity: Considering electoral context and variance among actors." *Journal of Information Technology & Politics* 14(2):154–167.

Meglino, Bruce M and Elizabeth C Ravlin. 1998. "Individual values in organizations: Concepts, controversies, and research." *Journal of management* 24(3):351–389.

Metz, Florence and Laurence Brandenberger. 2023. "Policy networks across political systems." *American journal of political science* 67(3):569–586.

Neubaum, German. 2022. ""It's going to be out there for a long time": The influence of message persistence on users' political opinion expression in social media." *Communication Research* 49(3):426–450.

Ostrom, Elinor. 2010. "Polycentric systems for coping with collective action and global environmental change." *Global Environmental Change* 20:550–557.

Palosaari, Esa, Ted Hsuan Yun Chen, Arttu Malkamäki and Mikko Kivelä. 2024. "My Views Do Not Reflect Those of My Employer: Differences in Behavior of Organizations' Official and Personal Social Media Accounts." *arXiv preprint arXiv:2409.11759* .

Ramirez, Fanny A. 2018. "Social media affordances in the context of police transparency: An analysis of the first public archive of police body camera videos." *Journal of Applied Communication Research* 46(5):621–640.

Robertson, Craig T, William H Dutton, Robert Ackland and Tai-Quan Peng. 2019. "The democratic role of social media in political debates: The use of Twitter in the first televised US presidential debate of 2016." *Journal of Information Technology & Politics* 16(2):105–118.

Rodriguez, Pedro L, Arthur Spirling and Brandon M Stewart. 2023. "Embedding regression: Models for context-specific description and inference." *American Political Science Review* 117(4):1255–1274.

Ronzhyn, Alexander, Ana Sofia Cardenal and Albert Batlle Rubio. 2023. "Defining affordances in social media research: A literature review." *New Media & Society* 25(11):3165–3188.

Segerberg, Alexandra and W Lance Bennett. 2011. "Social media and the organization of collective action: Using Twitter to explore the ecologies of two climate change protests." *The Communication Review* 14(3):197–215.

Siegert, Steffi and Jan Löwstedt. 2019. "Online boundary work tactics: an affordance perspective." *New Technology, Work and Employment* 34(1):18–36.

Smirnov, Oleg and Pei-Hsun Hsieh. 2022. "COVID-19, climate change, and the finite pool of worry in 2019 to 2021 Twitter discussions." *Proceedings of the National Academy of Sciences* 119(43):e2210988119.

Stier, Sebastian, Wolf J Schünemann and Stefan Steiger. 2018. "Of activists and gatekeepers: Temporal and structural properties of policy networks on Twitter." *New Media & Society* 20(5):1910–1930.

Theocharis, Yannis. 2015. "The conceptualization of digitally networked participation." *Social Media+ Society* 1(2):2056305115610140.

Van de Ven, Andrew H, Andre L Delbecq and Richard Koenig Jr. 1976. "Determinants of coordination modes within organizations." *American sociological review* pp. 322–338.

Vu, Hong Tien, Hung Viet Do, Hyunjin Seo and Yuchen Liu. 2020. "Who leads the conversation on climate change?: A study of a global network of NGOs on Twitter." *Environmental Communication* 14(4):450–464.

Walter, Stefanie, Ines Lörcher and Michael Brüggemann. 2019. "Scientific networks on Twitter: Analyzing scientists' interactions in the climate change debate." *Public Understanding of Science* 28(6):696–712.

Ylä-Anttila, Tuomas, Antti Gronow, Mark CJ Stoddart, Jeffrey Broadbent, Volker Schneider and David B Tindall. 2018. "Climate change policy networks: Why and how to compare them across countries." *Energy Research & Social Science* 45:258–265.