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Mapping the ideological networks of American climate politics

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Abstract How do we understand national climate change politics in the United States? Using a methodological innovation in network analysis, this paper analyzes discussions about the issue within the US Congress. Through this analysis, the ideological relationships among speakers providing Congressional testimony on the issue of climate change are mapped. For the first time, issue stances of actors are systematically aggregated in order to measure coalitions and consensus among political actors in American climate politics in a relational way. Our findings show how consensus formed around the economic implications of regulating greenhouse gases and the policy instrument that should do the regulating. The paper is separated into three sections. First, we review the ways scholars have looked at climate change policymaking in the United States, paying particular attention to those who have looked at the issue within the US Congress. Next, we present analysis of statements made during Congressional hearings on climate change over a four-year period. Our analysis demonstrates how a polarized ideological actor space in the 109th Congress transforms into a more consensual actor landscape in the 110th Congress, which is significantly less guided by partisan differences. This paper concludes by discussing how these findings help us understand shifting positions within American climate politics and the implications of these findings.

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1 Introduction

How do we understand the lack of a national climate policy in the United States? Under both Democratic and Republican Party leadership, the US has been unsuccessful in passing legislation that regulates the emission of greenhouse gases. Since the Kyoto Protocol entered into legal force on 16 February 2005, a number of bills have been proposed in the US Congress that would establish a federal climate change policy, but none have successfully been passed through both houses of the Congress and entered into law.[1]

Social scientists have attempted to understand this lack of a federal climate change policy in many ways, focusing on various aspects of the issue (e.g. Christiansen 2003; Fisher 2004; Fletcher 2009; Harris 2000; Hovi and Skodvin 2008; Jacques et al. 2008; Lisowski 2002; Lutzenhiser 2001; McCright and Dunlap 2000, 2003; Rabe 2004, 2010; Rudel 2001; Selin and VanDeveer 2007; Victor and Council on Foreign Relations 2004; see also Gelbspan 1997; Leggett 1999; Ward et al. 2008 for more popular accounts). On the one hand, there have been numerous studies that focus on climate change politics in the US to understand how national politics contribute to the American position in international negotiations and within the global climate change regime (for recent accounts, see particularly Bang et al. 2007; Paterson 2009; Skodvin and Andresen 2009). On the other hand, a growing number of scholars have looked at the policy-making process specifically within the United States. Much of this research has assessed the relationship between sub-national and national policymaking around the issue (see e.g. Fisher Forthcoming; Jones 1991; Rabe 2007, 2009; Selin and VanDeveer 2009; Vasi 2006).

Although the studies are numerous, very little research to date has analyzed the role that specific actors play within the US Congress (but see McCright and Dunlap 2003; Fisher 2006; Liu et al. 2011). This paper builds on this limited work to analyze how the actors involved in discussions about climate politics in the US are ideologically related, and how these interactions help explain climate politics in the United States over time.

This paper is separated into three sections. First, we review the ways that scholars have explained American climate politics, paying particular attention to those who study climate change policymaking in the US Congress. Next, we present analysis of Congressional hearings on climate change over a four-year period that employs an innovation in network analysis. This paper concludes by discussing how these findings help us understand American climate politics and how they have changed over time, as well as the role that different interests play.

2 Understanding climate change policymaking in the United States

As has been previously stated, there has been a good deal of research on the politics of climate change in the United States in recent years (e.g. Arimura et al. 2007; Fisher 2004; Harris 2000; Jacques et al. 2008; Lisowski 2002; Lutzenhiser 2001; McCright and Dunlap 2000, 2003; Rabe 2004, 2010; Selin and VanDeveer 2007; Skodvin and Andresen 2009; Victor and Council on Foreign Relations 2004). Much of this research focuses on explaining the US position in international climate change policymaking. In his attempt to explain the US withdrawal from the Kyoto Protocol, for example, Lisowski applies Putnam's logic of the two-level game between international and national politics (Putnam 1988; see also Evans et al. 1993). Lisowski finds that US President George W. Bush took advantage of politics

[1] For a summary of and comparison among the bills, see www.eenews.net/special_reports/climate_change_domestic/comparison_chart/ (Accessed 28 September 2011).

inside the United States to "legitimize his hawkish approach" internationally (2002:101). Although Lisowski suggests that President Bush worked within the US political system to further his perspective, more recent work suggests that the legislature continues to play a very big role in US climate politics. In his paper on US climate politics after the election of President Obama in 2008, for example, Paterson makes a compelling case to show why "effects of a new US President on global climate politics will be rather less than might be expected" (2009: 140).

Other studies are more specifically focused on climate change politics inside the country. Lutzenhiser, for example, aims to explain the U.S. position on climate change. Analyzing the different proposals for potential climate change policy in the United States, the author finds that, as of summer 2001, there was "no U.S. climate policy and little debate about one" (2001:512; but see Arimura et al. 2007). The author specifically focuses on political and economic factors to explain what he calls "non-policy" in the United States (see also Christiansen 2003 for a more recent account). There have been a limited number of studies that look at federalism and climate change policies in the United States to understand this "non-policy." These studies build on the general notion that subnational efforts have emerged to "fill a policy void left by federal inaction or refusal to act" (Krane 2007: 462; see also Jones 1991; Kraemer and Schreurs 2007; Rabe 2009; Selin and VanDeveer 2009). Analyzing legislative efforts in 2008–9 to pass a climate bill through both houses of the US Congress, Rabe finds "American climate change policy to date suggests considerable aversion to any strategy that would impose significant costs on citizens through energy taxation or equivalents" (2010: 605–6).

At the same time, there have been a number of studies that explain US climate politics by focusing instead on the role that different social actors play in political decisionmaking, with many of them focusing particularly on the role of conservative think tanks in climate change policymaking to understand the lack of a national climate change policy in the United States. Jacques, Dunlap and Freeman, for example, find that the conservative movement successfully challenged the science of climate change through publications that are linked to conservative think tanks (2008; see also McCright and Dunlap 2000, 2003; see also Hoffman 2011; Norgaard 2011). In an earlier investigation, McCright and Dunlap conclude that "the conservative movement and especially the conservative think tanks appear to have successfully affected our nation's policymaking, this time with international implications" (2003:370; see also 2000).

2.1 Studying the US congress

Although the overall theme of the research on climate change politics in the United States has focused on national policymaking, looking at the challenges within the US, as well as how the politics inside the country contribute to the country's position in international negotiations about the issue, there is a small number of studies that explore these politics within the legislative branch of the government (e.g. Fisher 2006; Liu et al. 2011; McCright and Dunlap 2003; Park et al. 2010). Fisher, for example, looks at the role that different interests play in the voting behavior of Senators (2006). She concludes: "how society uses natural resources such as coal contributes to the influence that such natural resource interests can wield in the policy-making process" (2006: 488; see also Skodvin and Andresen 2009).

Congressional hearings are an important part of the policymaking process in the United States. In the words of the Governmental Printing Office, they are the principal way that Congress members "obtain information and opinions on proposed legislation, conduct an investigation, or evaluate/oversee the activities of a government department or the

implementation of a Federal law."[2] The importance of such hearings as a source of information has been noted within the academic literature as well (see particularly Arnold 1990; Baumgartner and Jones 1993; Burstein and Hirsh 2007; Clifton 2004; Gormley 1998; Liu et al. 2011). Testimonies at hearings are given by a range of policy actors, including governmental agency officials, interest groups, businesses, think tanks, academic researchers, as well as members of the US Congress (for a discussion, see Burstein and Hirsh 2007; DeGregorio 1998). Congressional hearings provide a forum for different policy actors to get their perspectives recognized and garner the attention and support of different political contingencies. These testimonies inform decisionmakers about topics ranging from science, technology, economics and policy. In the words of Burstein and Hirsh, "Members of Congress believe that hearings provide an efficient way to gather information and exert influence….Interest organizations, too, see hearings as important venues for conveying information" (2007: 179; see also Laumann and Knoke 1987).

Specifically building off of the research on agenda-grabbing and agenda setting in political science (for a summary of these theories, see Kingdon 1995; Baumgartner and Jones 1993; Jones and Baumgartner 2005), Liu and his colleagues incorporate data on Congressional Hearings in their efforts to understand media and Congressional attention to climate change (2011). Within the study, the authors analyze the annual number of Congressional hearings on climate change as a measure of Congressional attention to the issue, finding that the change in number of Congressional hearings on climate change was associated with international events, climate conditions, and what they call "climate science feedback" (2011: 415). In other words, the authors find that, along with other factors, the more climate change-related articles were published in scientific journals the previous year, the more attention the issue received in the mainstream media and the Congress. Similarly, in his book on the political economy of expertise, Esterling compares the politics of sulfur emissions trading to school choice and HMO promotion to understand the use of expert policy ideas in politics (2004). The author concludes that there are different patterns of debate within Congressional hearings that can be explained by "predictions appropriate to the state of knowledge for each policy and each case" (2004: 234).

Coming from a different perspective, Park and colleagues use Congressional hearings on climate change to investigate the ways that various issues are framed in political debates (2010). The authors find that hearings on climate change are much more likely to occur in Democrat-controlled Congressional sessions, and that Democratic Congresses tend to feature testimony from more pro-environment political actors and mainstream scientists (2010: 12). When the Republicans hold the majority in Congress, in contrast, testimony about the issue primarily comes from speakers in the business and industrial sectors. Moreover, the content of the testimonies are more likely to challenge the science of climate change and discuss potential negative impacts of climate change policy on economic growth and foreign relations (Park et al. 2010: 12–13; see also McCright and Dunlap 2003).

Although the studies of Congressional Hearings on climate change are quite limited, there are a small number of scholars who have specifically looked at who speaks in Congressional hearings more generally to understand the policy-making process (e.g. DeGregorio 1998; Burstein and Hirsh 2007). In their work studying policy innovation in the US Congress, Burstein and Hirsh analyze the Congressional testimonies of a random sample of policy proposals to understand their outcome (2007). Looking at the interest groups that contribute to policy discussions through Congressional hearings, the authors conclude that "Information—particularly information regarding policy effectiveness—does affect the likelihood that a policy

[2] http://www.gpo.gov/help/about_congressional_hearings.htm (Accessed 28 September 2011).

proposal will be enacted" (2007: 174). In other words, if policy makers are knowledgeable about the likely success (or failure) of a policy instrument, they are also more likely to adopt (reject) this instrument. Analyzing individual preferences and "policy beliefs" (Sabatier and Weible 2007) is key to understanding what courses of action are taken by a collective decisionmaking body like the US Congress.

Although this research takes an important first step in understanding Congressional Hearings, very little of it specifically focuses on climate change policymaking within the US Congress. Moreover, it has yet to analyze explicitly the relationship between the *content* of the discussions within the Congress and variation in the collective policy outcome. This paper, accordingly, applies an innovation in social network analysis to map the ideological networks of American climate politics within the US Congress.

In order to measure policy beliefs of decision makers, several kinds of data sources are available. This study analyzes text data from testimonies in the US Congress rather than full-text archives of news media, which has been explored in other contexts (see e.g. Hoffman 2011). Although secondary sources like the news media can help to uncover some of the central topics around climate policy, data on Congressional testimonies provide direct accounts of the discourse and debate around climate legislation, as well as the issue more broadly. As a result, the perspectives presented during Congressional hearings are an ideal data source for understanding the political alliances around the main issues being debated. The structure of these alliances constrains or promotes active policy-making related to climatic change. It is, hence, crucial to know the character and shape of these alliances and how they change over time. Measuring this causal antecedent is a necessary step for understanding temporal variation in the design of climate change legislation or its absence. In the pages that follow, we discuss how our data were collected and analyzed, and then present our findings to show how the perspectives presented therein are ideologically related.

3 Data and methods

In this dataset, the testimonies from climate change hearings during the 109th and 110thsessions of the US Congress were analyzed. The 109th (January 3, 2005-January 3, 2007) and 110th Congresses (January 3, 2007–January 3, 2009) were during the second term of George W. Bush's Presidency. During this time period, 341 pieces of legislation, such as bills, resolutions and amendments, pertaining to issues about climate change or global warming were introduced (106 in the 109th Congress[3] and 235 in the 110th Congress).[4] There was a Republican majority in both bodies of the US Congress during the 109th Congress: Republicans held 55% of the voting share in Senate and they held 53% of the voting share in the House of Representatives.[5] In the 110th Congress, however, Democrats controlled the majority of the House of Representatives with 54.3% of the voting share. During this Congressional session, Democrats held 49 seats in the Senate. However, the two Independent members of the Senate both caucused with the Democrats, which resulted in their holding 51% of the voting share during this session.[6]

[3] http://www.pewclimate.org/federal/congress/109 (Accessed 28 September 2011).
[4] http://www.pewclimate.org/federal/congress/110 (Accessed 29 September 2011).
[5] During the 109th Session of the US Congress, there was one independent member of the Senate and one independent member of the House of Representatives.
[6] For more detail, see www.senate.gov/reference/resources/pdf/RS22555.pdf (Accessed 28 September 2011).

A search for all hearings that discussed climate change was conducted through the Government Printing Office (GPO), which archives transcripts from Congressional hearings and makes them available for the public record.[7] Using the search terms "global warming" and "climate change," we identified all of the hearings that discussed these issues during the 109th and 110th Sessions of the US Congress (2005–2008). Although our primary resource for obtaining transcripts of testimonies is the GPO, the results of these searches were cross-referenced with two other sources to ensure accuracy: THOMAS,[8] the website and search engine for the Library of Congress; and the Pew Center on Global Climate Change, a non-profit that monitors climate change discussions and legislation in the US Congress.[9] The results of the searches from these three sources were compared to ensure that all of the hearings about climate change were accounted for and included in the dataset.

In addition to comparing these findings, the contents of each hearing were reviewed to confirm that the focus of each hearing was actually the topic of climate change. After this review, eight hearings in the 109th and three hearings in the 110th Session of Congress were excluded from the analyses. For example, Senate Hearing 109–448, the "U.S. foreign policy, petroleum, and the Middle East : hearing before the Subcommittee on Near Eastern and South Asian Affairs of the Committee on Foreign Relations, United States Senate," came up in our search. Upon review of the content of the hearing, it was determined that climate change was not its main focus. As a result, this hearing was removed from our analysis. In the end, our searches yielded 71 relevant hearings between 2005 and 2008. The transcripts of 29 hearings in the 109th Congress were analyzed, which included a total of 498 testimonies and statements. From the 110th Congress, there were 42 relevant hearings and 598 total testimonies and statements by members of the Congress. Only formal statements were included in the analysis. Comments made during the question-and-answer portion of the hearings were not analyzed.

The testimonies from these Congressional hearings comprised the dataset and the transcribed texts of each testimony were then transferred into the Discourse Network Analyzer program, which was used for data management, coding and conversion into network data (Leifeld 2012; cf. Leifeld and Haunss 2012). Discourse Network Analyzer (DNA) is a new computer program that allows for the qualitative coding of articles and statements and prepares the data for network analysis and visualizations so that the ideological relationship between the actors on each policy issue can be mapped and the strength of these ties can be quantified. Unlike other software packages for qualitative data analysis, DNA was designed to encode the policy beliefs and preferences of political actors appearing somewhere in the text (rather than merely encoding variables related to a whole text document). Once the "statements" of political actors have been tagged in a body of testimonies, these structured data can be converted into networks of speakers and their interconnection by commonly held policy beliefs or preferences.

The testimonies were organized by hearing number and speaker. In the cases where testimonies were submitted on behalf of an organization, but without a speaker actually testifying in person, the organization name was used. These speakers and organizations were then classified into seven types: (1) Businesses and Business Associations/Trade Groups, (2) Democratic members of the US Congress, (3) Environmental Groups, (4) Republican members of the US Congress, (5) Scientists, (6) US Executive Branch (which includes

[7] For details, see http://www.gpoaccess.gov/crecord/ (Accessed 28 September 2011).
[8] For details, see http://thomas.loc.gov/ (Accessed 28 September 2011).
[9] In November 2011, the Center for Climate and Energy Solutions became the successor of the Pew Center on Global Climate Change. For details, see http://www.c2es.org/federal/archives (Accessed 23 April 2012).

representatives from Government Agencies), and (7) Other, which includes the small number of Independent members of the US Congress.

The statements were coded for eight categories that are particularly relevant to discussions about climate change policy in the United States. Coding involved noting whether the speaker agreed or disagreed with the specific statement. Two of the categories were about the science of climate change, which has been a central theme in the climate change debate in the United States: "climate change is real and anthropogenic" and "climate change is caused by greenhouse gases." The six other categories were about different climate policy issues: "there should be legislation to regulate the emission of pollutants," "legislation should regulate carbon dioxide emissions," "legislation that regulates carbon dioxide emissions will not hurt the economy," "the United States should regulate carbon dioxide regardless of what developing countries do," "legislation should establish a market for carbon emissions (cap and trade)," and "there should be a carbon tax." Whenever a statement falling under one of the eight categories was made, the statement was coded. Sometimes specific testimonies included multiple statements that were coded in the same category. In some cases, statements included mention of both sides of the issue, suggesting that the speaker holds a moderate stance on the issue. For example, Peter Orszag, the Director of the Congressional Budget Office, gave a testimony on 1 November 2007 before the Committee on the Budget of the U.S. House of Representatives that presented both sides of the issue regarding the economic implications of regulating carbon dioxide emissions. In one part of the testimony he states that the regulation of carbon dioxide emissions "would produce long-term economic benefits by avoiding some future climate-related damage." In another portion of the testimony, he notes "there would, however, be costs as the economy adapted to lower emissions levels."[10]

The coding was performed by human coders according to a prespecified set of policy belief categories. As such, the qualitative coding was deductive. The results of each coder were validated by a research supervisor who maintained the coherence between individual coders. While there is no formal measure of intercoder reliability, the set of variables was clearly specified without much room for speculation. In rare cases of disagreement between a coder and the supervisor, a consensual solution was sought among team members.

Since we are interested in understanding climate change policymaking in the US Congress, this paper presents the results for three of the codes from this analysis that have been central themes in the American climate change debate during the period of our study: "legislation should regulate carbon dioxide emissions," "legislation that regulates carbon dioxide emissions will not hurt the economy," and "legislation should establish a market for carbon emissions (cap and trade)." Although later discussions have explored the viability of a carbon tax in the United States, during the period of our study, cap-and-trade legislation was the only policy instrument under consideration. The three codes were selected on the basis of their importance for climate policy-making during the period of inquiry. They reflect the major ideological divisions that are often cited in the literature on climate change framing and discourse, and as such they are substantively interesting for understanding political alliances and the formation of consensus regarding climatic change.

In the appendix to this paper, we present descriptive statistics about the data set including overall statement frequencies in Congressional hearings over the period of inquiry (Fig. 6), the distribution of issue stances among different actor types for the different time periods (Table A1), and the shares of actor types present in the data set in the two time periods under

[10] The full testimony is available at: http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=110_house_hearings&docid=f:39491.pdf (Accessed 28 September 2011).

consideration (Table A2). In addition, the correlations among the issue stances via actors are listed in Table A3.

3.1 Network analysis technique

A "statement" is a text portion where an actor reveals his or her policy beliefs or preferences in the text (Leifeld and Haunss 2012). Each relevant statement of a political actor was coded for four variables: the name of the actor, the classification of the policy actor into one of the seven types, the issue addressed by the actor (that is, the seven policy belief codes, three of which are analyzed below), and a dummy variable indicating either a positive or a negative stance on the issue.

All statements were transformed into an actor-by-issue matrix where each issue occupies two distinct columns—one for positive statements where the actor supports the claim and one for negative statements where the actor rejects it (i.e., reflecting agreement and disagreement with each policy instrument or causal perception). In network terminology, it can be understood as an affiliation matrix with two classes of nodes: actors and policy beliefs. To avoid confounding the quantity of an actor's statements and the actor's qualitative preferences, we dichotomized the affiliation matrix in some of the procedures that follow, retaining "0" values where present and replacing positive values by the value "1." In the multivariate network procedures described below, this process guarantees that actors are modeled as showing a high degree of belief similarity if they judge many different issues in the same way, not if they agree on a single claim repeatedly during Congressional Hearings.

The rectangular actor-by-issue affiliation matrix was then converted into a square actor-by-actor matrix (a so-called co-occurrence matrix), where the cell entries reflect the number of shared issue stances between the row actor and the column actor (see Leifeld and Haunss 2012, for a methodological description in matrix notation). Diagonal entries ("loops" in the language of social network analysis) were left blank because they merely show the number of policy beliefs an actor referred to in total and hence they do not exhibit any useful relational pieces of information. A co-occurrence matrix can be interpreted as an undirected and weighted network, that is, edges reflect the *strength* of ideological association between two actors rather than merely the presence of an ideological tie, and actor A's similarity to actor B is the same as actor B's similarity to actor A. The network can be visualized as a graph with actors as vertices and the number of shared issue stances as edge weights between these vertices. Clusters of nodes in this network represent political coalitions, based on the assumption that coalitions can be measured in terms of their similarity of policy beliefs and preferences. The discourse network is a good overall indicator of the empirical existence of coalitions, their between-group polarization and their within-group congruence in US climate politics, hence we call it a "congruence network" (in line with Leifeld and Haunss 2012).

Ideologies are composed of rather general, as well as specific, preferences and values. When coding the data, we focused on what Sabatier and Weible (2007) call 'policy core beliefs' because they are the 'glue that binds coalitions together.' Policy core beliefs are preferences regarding the key dimensions of a specific policy. A full array of network-analytic methods can be used to analyze the congruence network. In our analysis, we employ network density (Scott 2000) and a hierarchical cluster analysis (see below) to describe the network structure, and embed these into a qualitative interpretation of the network diagrams and the political process. Density is a simple measure of how many ties exist in a network divided by the maximum number of ties possible (Scott 2000). It captures how crowded a specific network is in terms of its interconnections. A completely connected network has a

density of 1, and a network without any realized edges has a density score of 0. Density can also be computed for a subgraph instead of a whole network, or to assess the number of connections between subgroups of actors. In these cases, we call it "within-group" density and "between-group" density, respectively.

All cluster analyses and estimations of network density are based on two different networks: one for the 109th Congress and one for the 110th Congress. All actors and policy beliefs are contained within each of these two networks; there are no separate analyses for each issue category or for different subsets of actors. However, the different issue categories and actor type classifications mentioned above are employed to interpret the network structure in Figs. 4 and 5.

The degree of polarization deserves close attention with sophisticated methods. Comparable to several other methods like blockmodeling, clique analysis or projection techniques (for an overview, see Scott 2000), an agglomerative hierarchical cluster analysis (Jain and Dubes 1988) with Ward's optimization method (Ward 1963) can serve to assess the subgroup structure and hence polarization versus consensus in a network. There are two options from a methodological point of view: calculating structural similarity of actors based on their tie profiles in the *congruence network*, or calculating the similarity of actors based on similar row profiles in the *affiliation matrix*. We chose the latter option because the construction of the congruence network is already a non-isomorphic transformation of the original data. In other words, transforming the data several times before analyzing them would have possibly distorted the results and required further justification. An adequate measure of similarity for binary vectors like the rows of the affiliation matrix is the Jaccard coefficient (see Jain and Dubes 1988: 17 for details), which we use to compute the distance matrices for the cluster analyses. We compare issue coalitions in the 109th and 110th Sessions of the US Congress and derive subgroups for each of these time periods.

The choice of clustering techniques is often arbitrary, and different methods yield different results. We therefore opt for methodological triangulation by partitioning all actors into one out of two groups based on their tie profiles in the dichotomized affiliation matrix and comparing within-block and between-block network densities between the 109th and 110th Congress (Scott 2000). Actors with equal propensities toward the positive and the negative group were omitted from the density calculation. If density is high within a group, its internal coherence is high. The lower the density between the two blocks, the more extreme is their polarization. Low within- and high between-block densities would indicate the absence of a coalition structure.

4 Findings

In the pages that follow, we present the results of our analyses of climate change hearings in the 109th and 110th Sessions of the US Congress. As has been previously noted, descriptive statistics of our data set are available in the paper's Appendix. We start by looking at the cluster structure of the ideological landscape. Next we present ideological maps of how political actors are tied together by common issue stances and how positions in this network map are related to organizational affiliations of participants in these hearings. After assessing changes in the cliques and polarization between the two Sessions of the US Congress in terms of different actor types, we demonstrate how consensus evolves between the 109th and 110th sessions of the Congress by visualizing stances on the three issues as different node sizes, shapes and colors in the network. Finally, subgraphs containing only Democrats and

Republicans reveal that the findings extend to members of the Congress and are not limited to interest groups.

By looking at the descriptive statistics in the Appendix, we get a general sense of the various perspectives presented in the Congressional hearings on climate change during the 109th and 110th Sessions of the US Congress. It is clear that there was much more support for all of these categories in the later session of the Congress and that the position was supported by a more diverse set of policy actors in the more recent Congress. Although this analysis is consistent with the type of analysis conducted by the extant research (Burstein and Hirsh 2007; Gormley 1998; McCright and Dunlap 2003), the plain numbers do not tell us how consistent these positions are across the different categories and what the ideological landscape looks like at the aggregate level. Therefore, the first step in the analysis is to aggregate these different categories in a single congruence network for each of the two time periods, as described in the methodology section. Through this process, we are able to assess the overall ideological maps for all climate change hearings in the two sessions of Congress.

In this analysis, policy actors are separated into clusters based on their similarity across the three categories, which are graphically depicted as a dendrogram. The height of the dendrogram represents the (dis)similarity of the clusters. The higher the height at which two branches are merged, the less similar they are overall. Conversely, the lower the agglomeration height where two actors or branches are merged, the higher is their similarity. Placement of actors within each group is random.

Figure 1 presents the results of this analysis of the three categories together for the 109th Congress. Speakers within the 109th Congress separate out into two distinct "camps" in this analysis: one dominated by Republicans and business groups on the left of the diagram, which oppose the categories; and the other dominated by Democrats and environmental groups on the right, which support them. The densities for each group are relatively consistent: 0.79 for those taking the oppositional stance and 0.67 for those who take the supportive stance. These findings are consistent with those scholars who find that the issue of climate change has been relatively partisan in the US Congress, with Democrats and

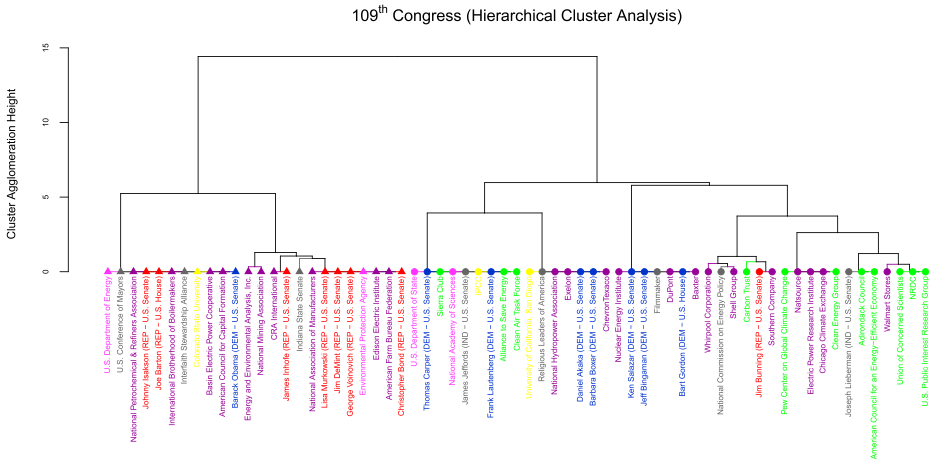

Fig. 1 Dendrogram of 109th Congress. **Notes:** The left side of the diagram represents opposition. Position within the clusters cannot be meaningfully interpreted in the dendrogram. **Key**: *Blue* indicates Democrats in Congress, *Green* indicates environmental groups, *Pink* indicates representatives from the executive branch of the government, *Purple* indicates businesses and business and trade organizations, *Red* indicates Republicans in Congress, *Yellow* indicates scientists, and *Grey* indicates policy actors that fall into the "other" category

environmental groups having an oppositional perspective to that of Republicans and business interests (McCright and Dunlap 2003; Park et al. 2010; see also Esterling 2004).

Turning to the 110th Congress, the bifurcation has disappeared: the cluster analysis does not fall into two specific camps. Instead, smaller cliques emerge. For example, there is a small group of predominantly Republican Members of Congress who oppose all three categories in the center of the diagram. At the same time, Republican members of Congress also end up in other parts of the diagram. This distribution suggests that climate change is not a partisan issue within the 110th Congress. Similarly, environmental groups are uniformly distributed across the different clusters. Coalitions are much less clear-cut than before, and the transitions between the camps are fluent. Clusters are rather nested within each other, which is an indicator of the lack of separation between ideologies. Figure 2 presents a dendrogram of the three categories together for the 110th Congress. In the 110th Congress, the density of the groups of actors supporting the issue is almost the same as in the 109th Congress: 0.63. This finding suggests that this cluster is rather stable. The density for the group opposing the issue, however, has dropped 0.24 to 0.55, which indicates that it is weaker than the comparable group in the 109th Congress and in relation to those who supported this issue in the 110th Congress.

To ensure that the results are not an artifact of the clustering method in this analysis, we next analyze the structure of preferences using the aggregated congruence network of all three categories. These results are shown in Fig. 3. Gray edges indicate that two actors share one single issue stance, and bold, black edges indicate that they share two or more issue stances. In line with the previous analyses, there are several interesting findings. First, the composition of the group of supporters of a pro-active climate policy becomes more heterogeneous over time. While this group is mainly composed of Democrats in Congress, and environmental non-governmental organizations in the 109th Congress, many Republicans, business associations/firms, and scientists join this group in the 110th Congress. Second, the number of supporters grows substantially over time while the group size of

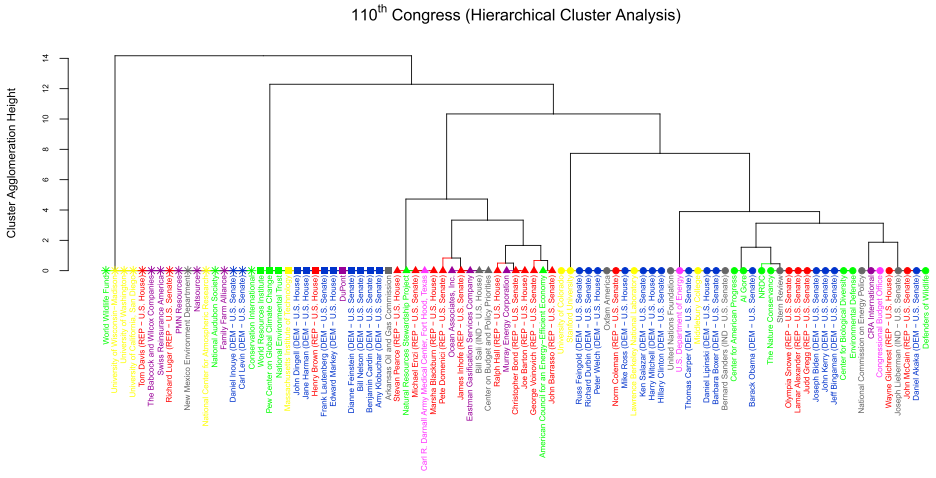

Fig. 2 Dendrogram of 110th Congress. **Notes:** same as in figure 1. **Key**: *Blue* indicates Democrats in Congress, *Green* indicates environmental groups, *Pink* indicates representatives from the executive branch of the government, *Purple* indicates businesses and business and trade organizations, *Red* indicates Republicans in Congress, *Yellow* indicates scientists, and *Grey* indicates policy actors that fall into the "other" category

the actors opposing climate politics sharply decreases from the 109th to the 110th Congress. Third, as already suggested by the density measure presented above, the coherence of the group that opposes these categories, which is depicted on the right side of the diagrams, is declining between the two time periods. For those who support the issue and who are depicted by the coalition on the left, the density measure is constant. Fourth, in both time periods, environmental groups shape the center of one camp, and business organizations and Republicans in the Congress are at the center of the other camp. Fifth and finally, black edges, which represent higher rates of agreement between actors, are prevalent *within* each of the two camps in the 109th Congress. In the 110th Congress, however, these strong ties are predominant *between* the two groups. We interpret this difference as an erosion of the bipolarity observed in the former time period. This finding is consistent with the main finding of the cluster analysis presented above.

Next, we turn to the analysis of the kind of consensus that emerges between the 109th and 110th sessions of the US Congress. While Fig. 3 visualizes actor types as node colors and actors' statement frequencies as the size of the vertices, Fig. 4 visualizes the issue stances and shows the consensus more clearly. The issue "Legislation that regulates carbon dioxide emissions will not hurt the economy" is visualized by using different vertex colors (blue = positive statement, red = negative, gray = no statement at all made by this actor). "Legislation should regulate carbon dioxide emissions" is visualized by using different vertex shapes

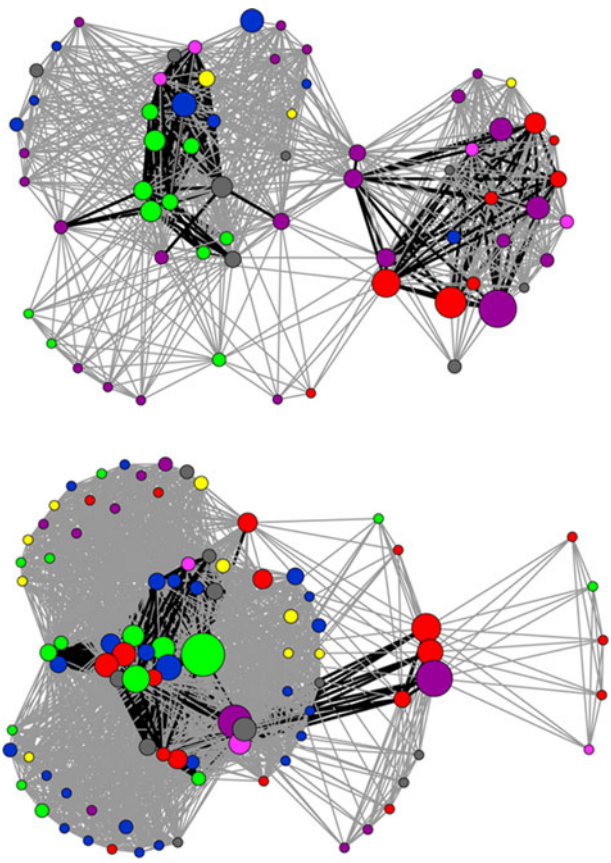

Fig. 3 Aggregated congruence network – visualization of actor types. **Notes:** Aggregate network visualizations for the 109th (*upper diagram*) and 110th Congress (*lower diagram*). The right side of the diagrams represents opposition; node size is a function of statement frequency; and spatial proximity cannot be meaningfully interpreted in network diagrams. **Key**: *Blue* indicates Democrats in Congress, *Green* indicates environmental groups, *Pink* indicates representatives from the executive branch of the government, *Purple* indicates businesses and business and trade organizations, *Red* indicates Republicans in Congress, *Yellow* indicates scientists, and *Gray* indicates policy actors that fall into the "other" category. *Dark and bold edges* indicate agreement on more than one issue stance

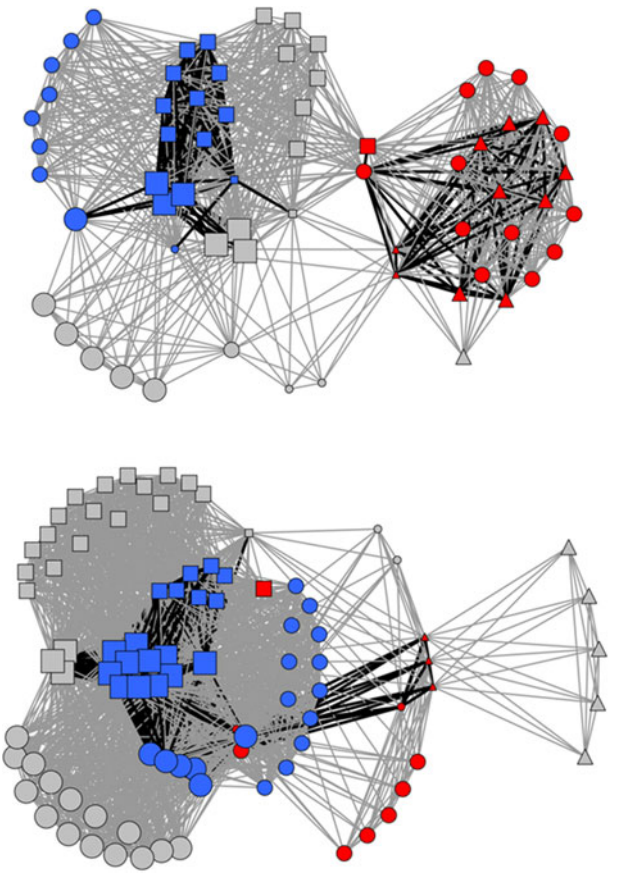

Fig. 4 Aggregated congruence network – visualization of issue stances. **Notes:** Aggregate network visualizations for the 109th (*upper diagram*) and 110th Congress (*lower diagram*). The right side of the diagrams represents opposition. Spatial proximity cannot be meaningfully interpreted in network diagrams. **Key:** *Node color* indicates different stances in the statement category "Legislation that regulates carbon dioxide emissions will not hurt the economy" (blue = yes; red = no; gray = no statement available). *Node shape* indicates different stances in the category "Legislation should regulate carbon dioxide emissions" (rectangle = yes; triangle = no; circle = no statement available). *Node size* indicates different stances in the category "Legislation should establish a market for carbon emissions (cap and trade)" (large = yes; small = no; medium = no statement available). *Dark and bold edges* indicate agreement on more than one issue stance

(rectangle = positive, triangle = negative, circle = NA). "Legislation should establish a market for carbon emissions through cap-and-trade" is visualized by using different node sizes (large = positive, small = negative, medium = NA).

In this figure, it is evident that the economic issue can account for the largest share of consensus among the actors across both sessions of the Congress. Although the 109th Congress is polarized between blue and red nodes, most of the red vertices turn blue in the 110th Congress, and both factions move toward the center of the diagram. The negative faction of the carbon dioxide legislation issue (triangles) also lose support, and there is a significant increase in cap and trade proponents (large nodes). Most importantly, however, the whole discourse network looks far more integrated in the 110th Session, with some red circles amidst the blue faction tying the opponents of the economy and carbon dioxide legislation categories closer to the center of the plot.

This integration is possible because there are several actors who—unlike in the previous Session—send out mixed signals regarding their policy-related beliefs. In contrast to the 109th Congress, there are much fewer actors who use more than one issue in a negative way. Except for three small, red triangles and an adjacent small, red circle, there are no such cases in the 110th Congress. There are, however, many red triangles in the diagram of the 109th Congress. This change shows that the hard-nosed opponents of a climate policy have lost ground by the time of the 110th Congress. It also provides evidence for a decrease in the

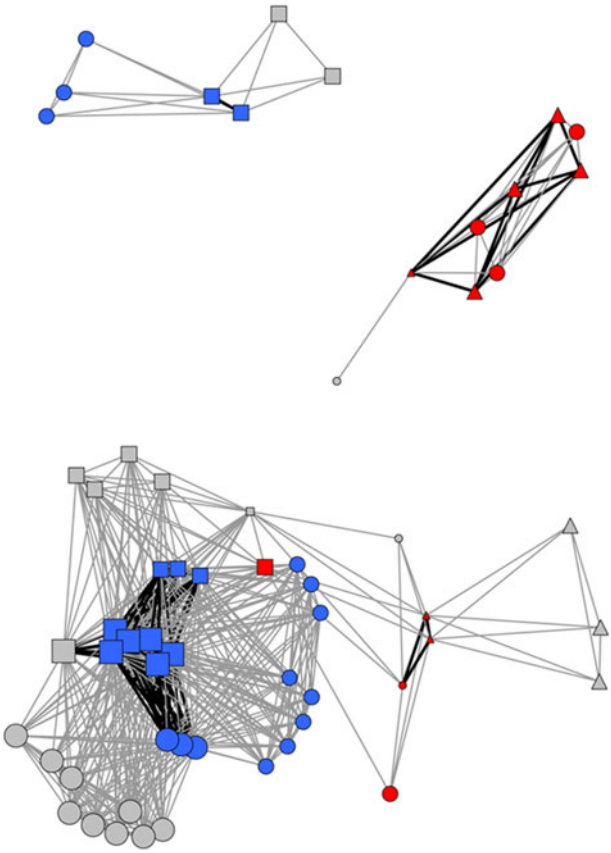

Fig. 5 Notes and Key: same as in figure 4

polarization over time. Actors who support all three categories (the large blue squares on the left), in contrast, have become much more frequent, and actors evaluating two out of three issues positively are spread around this core group and are also much more numerous.

Finally, our analysis distinguishes between policy-makers and organizational attendees of Congress meetings. An increasing consensus is only consequential if it extends to legislators, who are the actors responsible for passing legislation. Figure 5 presents the same visualization as Fig. 4 and retains the coordinates of the nodes, but it includes only legislators and omits all organizational actors. As is clear in these figures, the emerging consensus is even stronger among policy-makers than among organizations. It is worth noting that one of the reasons for their being fewer policy-makers engaged in discussions around this issue in the 109th Congress is that law-makers introduced less than half as many bills related to the issue of climate change in the 109th session of the Congress.[11]

Our results show that the two distinct components from the 109th Congress are merged into one giant component in the 110th Congress. This result is not particularly surprising given that organizations usually speak for vested interests with stronger intrinsic policy-related preferences.

[11] For more information, see http://www.c2es.org/federal/congress/110 (Accessed 23 April 2012).

5 Discussion and conclusion

Overall, by using the new technology of the Discourse Network Analyzer to analyze the content of Congressional hearings on climate change, we are able to map ideological networks around the issue over time. These findings provide a much clearer picture of changes within US climate politics over this four-year period. Applying this innovation in social network analysis we go beyond the views of current scholars who analyze US climate change politics by looking at the policy outcome in terms of the passage (or non-passage) of Congressional legislation (e.g. Fisher 2006; Lisowski 2002, Lutzenhiser 2001) and the limited studies that assess who speaks in Congressional Hearings (e.g. Burstein and Hirsh 2007; Gormley 1998; Liu et al. 2011; McCright and Dunlap 2003; Park et al. 2010). Instead, this method allows us to assess shifting positions within the US Congress. Furthermore, we are able to identify emergent cliques of climate policy supporters and opponents over time. By analyzing the *content* of discourse within the testimonies in Congressional hearings, rather than just the number of hearings and the affiliations of witnesses participating in them, we are able to show how interest groups and politicians change their preferences over the course of two sessions of the US Congress from 2005 to 2008. These changes provide empirical support to the claim that there was consensus forming around the issue of climate change in the US Congress during the 110th session of Congress.

Although our analysis goes beyond that conducted by other scholars who have looked at data from Congressional Hearings, there are some consistencies with the conclusions from this previous research. First, like the work by McCright and Dunlap (2003) and Park and his colleagues (2010), we do find a high level of partisanship across the participants in Congressional Hearings on climate change in the 109th Congress. In the 110th Session of Congress, however, the political party of speakers and the affiliations of participating interest groups no longer explain support and opposition for this issue.

The findings from both the 109th and 110th Sessions of the US Congress can also be explained, to some degree, by looking at the party that has the majority in Congress. In particular, these conclusions are consistent with those of Park and his colleagues, who find that hearings on climate change are more likely to take place during a Democrat-controlled Congressional session and that such hearings tend to feature testimony from more pro-environment political actors and mainstream scientists, which is in contrast to Republican-controlled Congressional sessions where testimonies tend to challenge the science of climate change and focus on the negative implications of regulating carbon dioxide (2010). Given these findings, it is not surprising that there was less polarization around the issue of climate change during the 110th Session of Congress, when the Democrats held the majority in the House of Representatives and the voting share in the Senate.

The results of our analysis show how the ideological networks around climate change in the US Congress changed over time: there was a noteworthy increase in supporters of climate change legislation and there was a simultaneous decrease in opposition to such legislation. Moreover, the diversity of actors supporting climate change legislation in terms of their organizational affiliations increased substantially and the support extended to members of the Congress themselves. Even with these changes, however, by the end of the 110th Congress, there continued to be opposition to federal climate change legislation.

Our findings that there was emerging consensus around the issue of climate change in the US Congress by the end of the 110th Congress are supported by the fact that the US House of Representatives passed a climate change bill for the first time ever during the 111th Congress

—the so-called Waxman-Markey bill (for a full discussion, see Rabe 2011).[12] With the Republican party taking over the majority of the House of Representatives in the 112th Session of Congress in January 2011, there is a clear need to extend this research to understand how climate politics and the discourse around these politics has changed more recently.

Thus, future research must analyze the content of hearings around climate politics in the more recent sessions of Congress to map out how ideological networks have continued to change. By extending the time period of analysis, we will be able to observe these trends over longer periods of time and assess whether changes we have observed between the 109th and 110th sessions of the US Congress may be a trend or part of larger random fluctuations. Until research is done on a wider time period, however, these findings must be interpreted with caution as there are other potential explanations that must be explored in future research. In particular, future research that includes data from more sessions of the US Congress will help to parse out the specific role that the party holding the majority in the Congress plays in shifting ideological networks.

Our findings also have implications to climate politics more broadly. Through our analysis of the ideological networks of American climate politics during two sessions of Congress, we are able to identify clear cliques that cross beyond partisan or other commonly understood coalitions. Looking at the actors who are ideologically positioned as part of different clusters in the aggregated networks, we can identify opportunities for collaborations that may not have previously been recognized. These findings can also be expanded with analysis of the content of Congressional hearings on climate change in more recent sessions of Congress. Such extended research will significantly enhance our understanding of climate politics, as well as providing a more robust account of ideological networks within American climate politics.

Appendix

In the pages that follow, we present descriptive statistics of the data used in our analysis.

Participation in congressional hearings on climate change

We begin by analyzing the types of actors who made statements during the climate change hearings in our sample. In contrast to what one might expect regarding hearings on the issue of climate change, most of the statements were not prepared by scientists (about 8% in the 109th and 11% in the 110th Congress). The majority of the speakers in both sessions of the Congress came from different branches of the US government. Although the hearings in both sessions of the Congress were dominated by government actors, there are a number of differences between these two sessions that are worth noting. First, there are striking differences between the government actors participating in the climate change hearings in these different sessions of the Congress. Even though the rules of the US Congress stipulate that the minority party is given the opportunity to call witnesses at Congressional hearings,[13]

[12] For more information, see www.govtrack.us/congress/bill.xpd?bill=h111-2454 (Accessed 28 September 2011).

[13] For a full discussion of these rules see http://lieberman.senate.gov/assets/pdf/crs/senatehearings.pdf for the Sentate and http://www.house.gov/house/Tying_it_all.shtml for the House of Representatives. (Accessed 28 September 2011).

participation in these hearings was very different in the two sessions of Congress. In the 109th Session of Congress, which had a Republican majority, almost a quarter of the statements (24%) were provided by Republican members of the Congress. During the 110th Session of the Congress, which had a Democratic majority, in contrast, only 5 % of people making statements were Republican members of the Congress. Although the level of Republican participation changed significantly during these two Congressional Sessions, Democratic participation remained relatively stable (24% and 20% respectively). At the same time, participation by the Bush Administration increased significantly between the 109th and 110th Sessions (10% and 22% respectively). Table A1 presents these results. There are also noteworthy differences among non-governmental actors. Participation by representatives of businesses and business or trade associations decreased between the 109th and 110th sessions of Congress (20% to 14%). However, environmental group participation went up between these two sessions of the US Congress (about 9% to almost 15% respectively).

How are actor types related to different concepts in the 109th and in the 110th Congress?

Although these results show that there are interesting patterns of participation during these two sessions of the US Congress, they do not tell us anything about the *content* of the Hearings. Accordingly, we now look at the distribution of issue stances among actor types in the 109th and 110th Congress for each of the three categories. Table A2 presents the number of statements per actor group and by time period and stance for each of the categories included in this analysis.

Legislation should regulate carbon dioxide emissions There is a high level of polarization around the question of whether legislation should regulate carbon dioxide in both sessions of the Congress. In the 109th Congress, 26 policy actors spoke in support of the category and 12 spoke against it. There was only one policy actor who presented a moderate position, speaking on both sides of this issue—both for and against emissions legislation that includes the regulation of carbon dioxide. In this session of Congress, the policy actors against this category were all Republicans, representatives of the Bush Administration, and representatives of businesses or trade associations. Those in support of this category, in contrast, were mostly Democrats in the Congress and environmental groups.

Table A1 Organizational affiliations of witnesses at congressional hearings on climate change (2005—2008)

	109th Congress	110th Congress
Business or Business Association/Trade Group	85 (20.6%)	54 (13.9%)
Democrat in Congress	100 (24.3%)	79 (20.2%)
Environmental Group	36 (8.7%)	58 (14.8%)
Republican in Congress	99 (24%)	19 (4.9%)
Scientist	34 (8.3%)	42 (10.7%)
US Executive Branch	41 (10%)	87 (22.3%)
Other	17 (4.1%)	51 (13%)
Total	412	391

Table A2 Number of statements per actor group and by time period and stance

	109th Congress		110th Congress	
	Yes	No	Yes	No
"Legislation that regulates carbon dioxide emissions will not hurt the economy."				
Democrats	5 (8)	1 (2)	14 (17)	0 (0)
Republicans	0 (0)	7 (19)	6 (8)	5 (12)
Government	2 (2)	2 (3)	2 (2)	1 (2)
Business	5 (5)	10 (25)	1 (1)	4 (19)
Environmental NGOs	6 (7)	0 (0)	5 (9)	0 (0)
Science	1 (2)	1 (1)	4 (5)	0 (0)
Other	3 (5)	2 (2)	6 (8)	3 (3)
Total	22 (29)	23 (52)	38 (50)	13 (36)
"Legislation should regulate carbon dioxide emissions."				
Democrats	4 (12)	0 (0)	9 (11)	0 (0)
Republicans	0 (0)	5 (12)	7 (10)	5 (6)
Government	2 (2)	1 (1)	1 (1)	1 (1)
Business	6 (8)	5 (16)	5 (6)	1 (3)
Environmental NGOs	8 (15)	0 (0)	9 (19)	1 (1)
Science	2 (2)	0 (0)	5 (6)	0 (0)
Other	4 (6)	1 (2)	4 (5)	0 (0)
Total	26 (45)	12 (31)	40 (58)	8 (11)
"Legislation should establish a market for carbon emissions (cap and trade)."				
Democrats	0 (0)	0 (0)	13 (20)	0 (0)
Republicans	0 (0)	2 (3)	6 (10)	5 (11)
Government	0 (0)	0 (0)	1 (1)	1 (1)
Business	4 (4)	4 (5)	2 (2)	2 (4)
Environmental NGOs	8 (8)	1 (1)	10 (21)	2 (4)
Science	0 (0)	0 (0)	1 (1)	0 (0)
Other	1 (1)	1 (1)	4 (6)	1 (1)
Total	13 (13)	8 (10)	37 (61)	11 (21)

Numbers in brackets indicate the raw number of statements, including instances where a speaker made the statement in a testimony more than once. The numbers outside the brackets reflect the number of different actors making this statement in the given time period

In the 110th Congress, there were far fewer actors speaking against the category and many more actors supporting it: only eight spoke against this category and 40 policy actors spoke in support of it. Actors against this issue continued to come from the same social groups. There was one environmental group—the Natural Resources Stewardship Project, which is a Canadian non-profit organization that is known to include a number of leading climate change skeptics.[14]

[14] For more information, see www.sourcewatch.org/index.php?title=Natural_Resources_Stewardship_Project (Accessed 28 September 2011).

At the same time, there were also businesses and Republicans in Congress who supported this position. Although this issue continued to be polarized in the 110th Congress, there was less opposition and more support for legislation to regulate carbon dioxide by a broader range of actors.

Legislation that regulates carbon dioxide emissions will not hurt the economy Statements during Congressional hearings on climate change frequently discussed the economic implications of regulating carbon dioxide. In the 109th Congress, there was a very high level of polarization around this issue. In fact, the debate was relatively balanced and there were almost an equal number of speakers for and against this category (22 versus 23 accordingly). Here again, those actors against the issue were predominantly Republicans in the Congress and businesses. Also like the first category, most of those actors who supported this statement were Democrats in the Congress and environmental groups. However, business and trade associations also supported this category.

In the 110th Congress, there was much less polarization: three different policy actors presented a moderate position, speaking on both sides of this category. Like the first category, support for the issue grew in this Congress and 38 actors spoke in support of the issue while 13 spoke against it in the later session. The increase in support also resulted in a broader diversity of actors supporting this category, including scientists.

Legislation should establish a market for carbon emissions through cap-and-trade This subject was not a main topic of discussion during Congressional hearings in the 109th Congress. In this session, only 21 people spoke about it in their statements: 13 policy actors spoke in support of this category and eight spoke against it. Supporters were mainly from environmental groups. Like the previous two categories, those actors against the issue were mostly Republicans in the Congress and businesses.

In the 110th Congress, there was a lot more discussion about this issue. Thirty-seven actors spoke in support of it and 11 spoke against it. Supporters in this Congress included Democrats and Republicans in the Congress, along with environmental groups and business groups. Opposition was made up almost entirely of Republicans in the Congress. It is worth noting that there was one environmental group that spoke in opposition to the establishment of a cap-and-trade system in the United States: the American Council for an Energy-Efficient Economy.

Figure 6 shows a graphical representation of the data from Table A2. The number of positive statements is increased between the 109th and 110th Sessions of Congress in all three cases, while the number of negative statements is generally decreased, with the exception of the cap-and-trade issue. Most importantly, however, the diagrams demonstrate that this pattern holds, and is even more pronounced, for both Democrats and Republicans in the US Congress. The increase of negative cap-and-trade statements can be largely attributed to Republicans, but their marginal increase in positive cap-and-trade statements even exceeds their marginal increase in negative statements of this kind.

Correlation between issues

Table A3 reports correlations between issue stances based on the raw number of statements of a certain kind per actor. It is noteworthy that the correlation between different issues is fairly high, while the correlation between positive and negative pairs of issue stances is low in all cases, as expected. Interestingly, the cap-and-trade issue is correlated with the other issues to a lesser extent, which is also reflected by the network analysis.

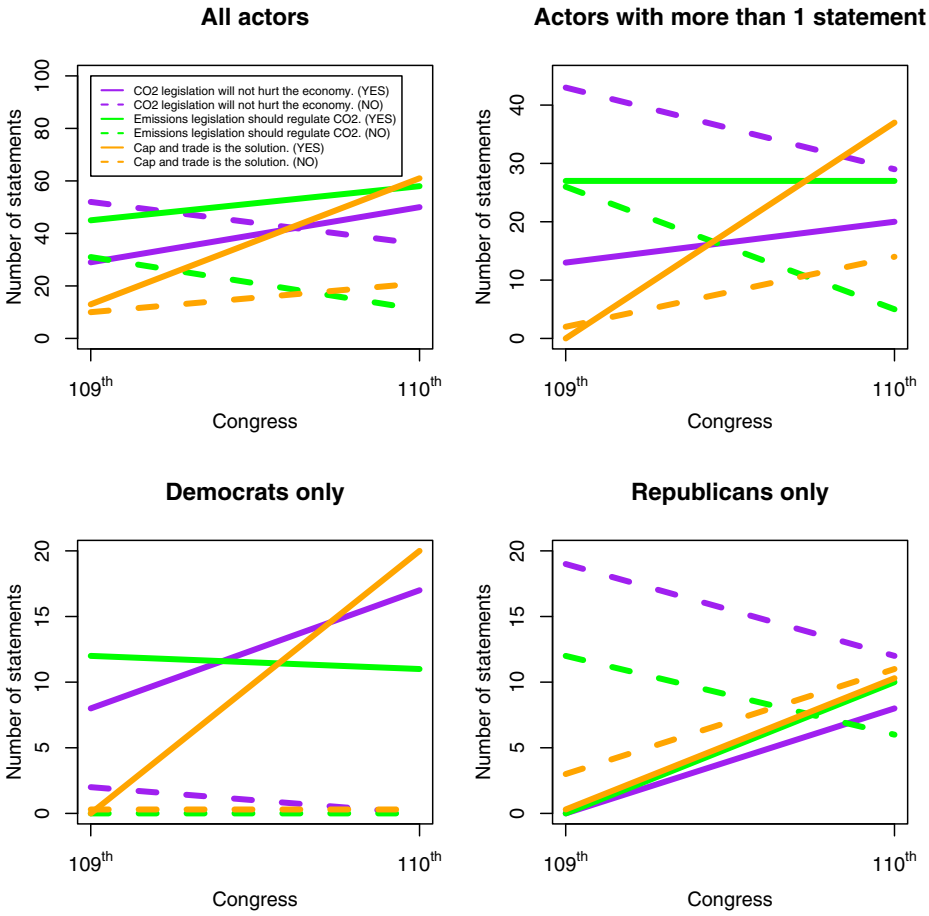

Fig. 6 Line charts

It is worth noting that the methods employed in this article do not require orthogonality of issues. The network analysis techniques presented in the article are rather a tool to analyze the dimensionality of the ideological space without being confined to two dimensions. The correlations are an interesting feature of the data, rather than an obstacle to the analysis.

Table A3 Correlations between issue stances

		YES			NO		
		Economy	CO2	Cap & Trade	Economy	CO2	Cap & Trade
Yes	Economy	1.00					
	CO2	0.59	1.00				
	Cap & Trade	0.48	0.44	1.00			
No	Economy	−0.04	−0.05	−0.04	1.00		
	CO2	−0.07	−0.06	−0.06	0.72	1.00	
	Cap & Trade	0.23	0.19	0.19	0.62	0.33	1.00

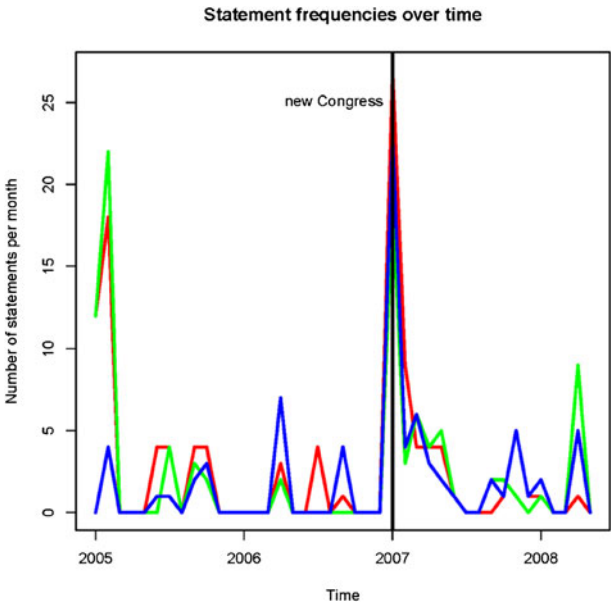

Fig. 7 Statement Frequencies over Time **Key:** green = "legislation should regulate carbon dioxide emissions;" red = "legislation that regulates carbon dioxide emissions will not hurt the economy;" and blue = and "legislation should establish a market for carbon emissions (cap and trade)"

Distribution of statements across time

Figure 7 shows the number of statements per month for all three issues. While most months are populated by a moderate number of statements, an extraordinarily high number of statements were made at the beginning of each of the two sessions of the US Congress that are included in this analysis.

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