

Scientists' views and positions on global warming and climate change: A content analysis of congressional testimonies

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Received: 26 August 2014 / Accepted: 15 March 2015 / Published online: 21 April 2015
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Abstract Among many potential causes for policymakers' contention over whether there is a largely unified scientific agreement on global warming and climate change (GWCC), one possible factor, according to the information deficit theory, is that the scientists who testified in congressional hearings might be substantially divided in their views and positions associated with GWCC. To clarify this, we perform content analysis of 1350 testimonies from congressional GWCC hearings over a period of 39 years from 1969 to 2007 and use the data derived from this content analysis to provide an overview of scientist witnesses' stances on GWCC. The key findings include: (1) among the scientists' testimonies with an expressed view on whether GWCC is real, a vast majority (86 %) indicates that it is happening; (2) among the scientists' testimonies with an identified stance on whether GWCC is anthropogenic, a great majority of them (78 %) indicates that GWCC is caused, at least to some degree, by human activity; (3) even under Republican controlled congresses, there is still a supermajority (75 %) - among the scientists' testimonies with an expressed position on GWCC existence or GWCC cause - that believes that GWCC is real and that GWCC is anthropogenic; (4) most scientists' testimonies (95 %) endorse pro-action policy to combat GWCC; and (5) the percentages of scientists' views and positions are consistent across different types of scientist testimony groups. Our findings suggest that the scientific information transmitted to Congress is not substantially different from the general agreement in the climate science community.

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1 Introduction

The problem of global warming and climate change (GWCC) is one of the greatest challenges facing governments around the world. Scientific assessment reports by the Intergovernmental Panel on Climate Change (IPCC) indicate that the warming of the global climate system is unequivocal and is mostly caused by the increase in greenhouse gas concentrations due to human activities such as the burning of fossil fuels (IPCC 2001, 2007). Multiple recent surveys of scientists' opinions on GWCC also find that the majority of scientists are convinced global warming is real and human activity is contributing to GWCC (Oreskes 2005; Doran and Zimmerman 2009; Anderegg et al. 2010; Rosenberg et al. 2010; Cook et al. 2013).

Despite these indicators of a largely unified scientific agreement on GWCC, there are different public perceptions and even opposite opinions about the science community's assessment on the existence and fundamental cause of GWCC (Leiserowitz et al. 2012; Pew 2012). In the United States, there are also controversies and confusions among the lawmakers, particularly in Congress, about climate science. For example, some members of Congress think that the climate science community has already provided overwhelming evidence and near-complete consensus indicating that "climate change is real" and "human activities are the primary cause" (Boxer 2013), while others contend that "manmade global warming is the greatest hoax ever" and "the evidence is overwhelmingly in favor of those who don't think human beings have significant influence on the climate system" (Inhofe 2003). These different perceptions and opposite claims among the lawmakers are often assumed to lead to policy gridlocks, constituting a major hurdle that slows down government policy actions to address GWCC.

Certainly there are many socio-economic-political factors (e.g., partisanship, constituency, prior belief, political ideology, cognitive information-processing biases, etc.) that may cause the discrepancy between climate scientists' knowledge and lawmakers' perceptions about GWCC, but one may argue, as various members of Congress have intimated, that there might be an information deficit within Congress. From an information deficit perspective (for a review, see Stoutenborough and Vedlitz 2014), one could argue that policymakers' contention over climate science could be caused by an inadequate and/or inaccurate transmission of scientific information from the science community to Congress. However, over the last several decades, numerous congressional hearings related to GWCC were conducted and hundreds of scientists provided their testimonies on GWCC. Thus, it is unlikely that climate science information was not adequately presented to Congress. This leaves open the other possibility – i.e., in the process of scientists giving testimonies, the near-complete scientific GWCC agreement might be inaccurately presented to Congress. More specifically, it is possible that lawmakers' contentious perceptions about climate science were caused by "a divided science" – that is, scientist testimonies in GWCC hearings might have given widely divided stances.

To examine whether this "divided science" might be the case, we conduct content analysis of all 1350 congressional testimonies related to GWCC over three decades from 1969 to 2007. We investigate what types of GWCC information have been provided by witnesses (particularly scientist witnesses) to Congress. We are particularly interested in analyzing the stances of scientist witnesses on three issues surrounding GWCC: (a) GWCC existence (i.e. whether GWCC is real and happening); (b) GWCC cause (i.e. whether GWCC is caused, to some degree, by human activity); and (c) GWCC policy position (i.e. whether government should take policy actions to address GWCC). We believe that our findings bear important implications for climate policy research.

2 An information deficit?

Though partisan rancor is common within Congress, members rarely make statements framed solely in ideological or partisan terms. Instead, their partisan and ideologically based positions are often framed through other mechanisms (e.g. morality, economic interests, and scientific perspectives). For example, Boswell (2009) argues that scientific knowledge is often only brought into a policy debate if it supports pre-existing beliefs, which allows the policymaker to point to this knowledge as the justification of their ideological or partisan views. This, then, provides strong political justification for bringing “experts” with views that run contrary to the scientific consensus on GWCC, as these contrary testimonies can provide the political justification for continuing to deny the existence of GWCC. This, in turn, creates a perception that there is divided science on this issue. For example, Representative Aderholt penned an op-ed for a local newspaper where he wrote, “I fall into the second group of people who believe, as do many very credible scientists, that the earth is currently in a natural warming cycle rather than a man-made climate change” (Aderholt 2009). He clearly relies on a “scientific” perspective to justify his disbelief in GWCC.

Conversely, some statements by members of Congress suggest that they do not understand the nature of the scientific consensus and climate research and that they are relying solely upon contrary science to justify their beliefs. For example, during the floor debate on the Clean Energy and Security Act, Representative Broun argued, “Scientists all over this world say that the idea of human-induced global climate change is one of the greatest hoaxes perpetrated out of the scientific community. It is a hoax. There is no scientific consensus” (Broun 2009). Similarly, Representative Burgess states, “My opinion, for what it is worth, is that the science behind global temperature changes is not settled” (Burgess 2011). If their statements were based solely on the information provided during congressional hearings, this suggests that there may be an information deficit caused by divided science.

An information deficit exists when an individual lacks a scientific understanding of an issue. It is often assumed that if these individuals are presented with factual and consistent scientific information, they will come to view the issue in the same manner as scientists (e.g. Bord et al. 2000; Hansen et al. 2003; Kellstedt et al. 2008; Stoutenborough and Vedlitz 2014). This expectation is consistent with that of rational choice theory, which assumes that when operating with the same or equivalent information, individuals should reach similar conclusions (e.g. Arrow 1982). Conversely, when there is a variation in the information input, different perceptions among the information receivers are likely to occur (e.g. Tversky and Kahneman 1986). Consequently, from this perspective, if the climate science presented to Congress is divided, then it is likely that there will be differing GWCC perspectives among the lawmakers.

Supporters of an information deficit approach assume that the solution to such a deficit is to simply provide more information, as long as that information is consistent with the overarching scientific assessment (e.g. GWCC is real, and it is likely caused by human activity). Many other researchers argue that this information deficit approach is a relatively simplistic view of the relationship between experts’ perceptions and those held by the public (e.g. Bulkeley 2000; Pielke 2007) or the media (Boykoff 2011). Many argue that other factors, such as cultural framings, values, social processes, and institutional factors – are better predictors (e.g. Burgess et al. 1998; Wynne 1992, 1996; see also Crow and Boykoff 2014, and Wesselink et al. 2013).

While we do not endorse the simplistic information deficit approach, we believe it should be examined empirically. Particularly when combined with the potential for “experts” of questionable expertise (see e.g. McCright 2007; Anderegg et al. 2010) to testify before Congress, it appears possible that members of Congress who do not believe there is a scientific consensus may

do so because they might have been presented with divided climate science information during congressional hearings. Given the rhetoric used by some members of Congress and the possibility of divided science presented to Congress, the information deficit approach would suggest that members of Congress are not being presented with information that adheres to the largely unified scientific agreement on GWCC.

To examine the possibility of an information deficit problem characterized by a divided science, we conduct content analysis of congressional GWCC testimonies to investigate who delivered the testimonies, what were the witnesses' GWCC stances, and whether the scientists' testimonies presented a substantially divided climate science regarding the existence and/or causes of GWCC. The answers to these questions will provide insights into why some members of Congress have contentious views over climate science either by identifying a potential cause of their behavior or by rebutting a red herring, thereby allowing climate policy scholars to focus on alternative explanations of this behavior.

3 Data collection strategy and content analysis method

The congressional hearing is the principal venue and formal instrument for members of Congress to gather the information needed to act as informed policy makers for scientifically and socially complex public problems (Baumgartner and Jones 2009; Liu et al. 2011; Oleszek 2013; see also Arnold 1990). Witnesses from the executive branch, concerned members of Congress, state and local governments, universities, think tanks, interest groups, and industries as well as knowledgeable citizens are often invited to congressional hearings to provide their opinions and assessments on the main issues being debated (Park et al. 2014; Oleszek 2013; Fisher et al. 2013a, b). Due to the scientifically complex nature of GWCC, many researchers, analysts and academics with scientific expertise and accumulated knowledge about climate systems have been called to testify in congressional hearings over the last several decades. Empirically examining the contents of congressional testimonies provides direct accounts of what information and messages scientist witnesses have presented to Congress.

Examining scientist witnesses' stances on GWCC requires systematic collection and content examination of relevant hearing and testimony data. To collect relevant data, we used Lexis-Nexis Congressional Publications—an online searchable archive.¹ Informed by previous research on GWCC (McComas and Shanahan 1999; Liu et al. 2008, 2011), we searched for three key terms—'climate change,' 'global warming,' and 'greenhouse gas*' ² in the Lexis-Nexis database and retrieved possible GWCC hearing and testimony records from 1969 to 2007 (a coverage period of 39 years was available in the Lexis-Nexis database when we conducted the research). We reviewed the contents of each record retrieved from the search and excluded duplicate records and those not focusing on GWCC issue— this yielded a final dataset with 1350 testimonies from 253 hearings.³

¹ The LexisNexis searchable database of congressional records (<http://web.lexis-nexis.com/congcomp>) was accessed and all the hearing and testimony data were collected in the spring of 2008 for a larger research project on national climate change policy processes.

² We used the wildcard key term 'greenhouse gas*' in order to obtain any record containing "greenhouse gas" or "greenhouse gases."

³ Over twenty different congressional committees in both the House and the Senate held GWCC-related hearings during the 39-year study period. These committees covered various jurisdiction areas and a wide range of issue interests, including agriculture, natural resources, science and technology, commerce, small business, energy, transportation, environment, public works, foreign affairs and relations, governmental affairs, budget, appropriations, etc.

Using standard content analysis methods and techniques (Neuendorf 2001; Riffe et al. 2005; See also, Krippendorff 1980; Weber 1985), we coded each hearing and testimony statement. We started with a pilot coding and then developed a detailed codebook with pre-specified coding categories and clearly defined variables. Two research assistants, who were trained extensively for 4 weeks with the codebook and coding procedures, completed all the coding.⁴ Our research team members supervised the coding. Most of the coded items were simply fact-based descriptions (e.g. witness's organizational affiliation) or statements (e.g. witness's view on whether GWCC is real and happening), and the coded variables were clearly defined and specified in the codebook. This left little room for the coders to speculate or make subjective judgment for their coding. For those rare occasions when either coder was not sure about how to code a specific item or both coders differed in how they coded a specific item, we held supervisor-coder meetings to review the document and collectively reach a consensual coding solution.

In addition to the basic information of each testimony (e.g. testimony time), we coded each testimony record by the following: (a) witness's scientific background; (b) witness's research organization type; (c) witness's view on GWCC existence; (d) witness's view on the human cause of GWCC; and (e) witness's stated stance on GWCC policy.⁵ Detailed information on the definition and operation of each coded item and categories are discussed in the following data section. There were a small number of testimony statements prepared by a panel of witnesses; for these cases, we coded the lead person's information in our dataset. All the coding was performed using a coding platform designed with Microsoft Access.

4 Data analysis and results

4.1 Witness and testimony composition

Before presenting the key results and findings on witnesses' stances on GWCC, we begin with an overview of the composition of all GWCC witnesses who testified from 1969 to 2007. In our coding we reviewed each testimony statement and identified the professional position of the witness (or the lead person of a witness panel). We examined the witness's official title and organizational affiliation reported in the testimony record,⁶ and coded each witness into one of two categories: (a) scientist; or (b) non-scientist.

A witness was classified as 'scientist' if the testimony was provided by a professor, researcher, or analyst who came from a research institution (e.g., university, national laboratory, academic society, or scholarly association) or came from a research unit or

⁴ After training, the coders were given 40 testimony records (randomly sampled from all 1350 testimonies) to code. We performed an inter-coder reliability check of these 40 coded testimonies and found over 90 % agreement between the coders (exceeding the 0.80-or-greater standard for reliable concordance in most content analysis practices). With this encouraging result, we had the coders continue with the remaining testimonies.

⁵ Witness's stances across the three questions on GWCC existence, human cause, and GWCC policy, may vary. For example, a witness may agree on one question (i.e. GWCC existence) but disagree on another (e.g. GWCC human cause). In our coding and data analysis, witness's stance on each of these three questions was treated separately.

⁶ The focus on reported profession and affiliation is a limiting condition of our measurement approach. Witnesses might have multiple affiliations, different past professions, etc. The data that were readily available did not include these potential alternative affiliations and professions. We believe this source of measurement error is rare (in most cases, the reported profession and affiliation are primary and representative of the witnesses' identities) and unlikely to bias the results.

department within a public agency, corporate/business, or non-profit organization. Scientist witnesses generally provided scientific perspectives and assessments based on their accumulated knowledge in their specialized research fields (e.g. climate systems, atmospheric science, oceanography, ecology, or earth and environmental sciences), though sometimes they also gave policy recommendations. All other witnesses, including members of Congress, non-research governmental officials, representatives of industries, non-research personnel of interest groups, and concerned individual citizens, were classified as ‘non-scientist.’ Non-scientist witnesses were usually called to express their opinions and interests as well as their policy recommendations and concerns; their testimonies were typically based on other broad social, political, and international dimensions rather than from credentialed scientific research perspectives, although they might also have given their lay-person’s views on scientific matters.

Our coding results indicate that among all 1350 testimonies, 752 (55.70 %) were provided by scientist witnesses while the remaining 598 (44.3 %) were provided by non-scientist witnesses. Gathering relevant information from both scientists and non-scientists is a typical practice used by Congress to address both technically sophisticated as well as socially and economically complicated issues. The relatively larger percent of scientists’ testimonies in the congressional GWCC hearings, in a sense, reflects the nature of GWCC as a scientifically complex issue.

One may argue that scientist witnesses come from different sectors in society with different funding sources and organizational supports, which may lead to various degrees of potential bias in their scientific research and assessment as well as in their interpretation and presentation of their research results. To address this, when we identified a scientist witness, we further examined his or her organizational affiliation and classified the organization into one of the following types: (a) ‘scientist from academic institution’ (e.g., university); (b) ‘scientist from government’ (e.g. U.S. national laboratory); or (c) ‘scientist from advocacy organization (e.g., research unit of a company or within an environmental organization).

The results from this classification indicate 278 (36.97 %) testimonies made by scholars from universities and academic associations, 253 (33.64 %) from government scientists, and 221 (29.39 %) from researchers of advocacy organizations such as industries and interest group organizations. The classification by scientists’ organizational type allows us to show that the GWCC information flowed from the scientific community to Congress on a broad and diversified base with each group of scientists contributing its views and assessments about GWCC. With this classification, we can also further examine whether and to what extent these three types of scientist groups differed in their messages to Congress (see detailed data analysis later).

4.2 Scientists’ views on GWCC existence and cause

Our unit of analysis is congressional testimony. In examining the contents of each testimony statement, we identified the witness’s stated view on GWCC existence – i.e., whether GWCC is happening or underway. We coded each testimony into four categories: (a) ‘yes;’ (b) ‘not sure;’ (c) ‘no;’ and (d) ‘no stated stance’ (i.e. witness did not express a view on this question). Note there were a small number of witnesses who testified more than once, and some of them might have expressed different views and positions over time. For the purpose of this study, we treated these multiple testimonies by the same person separately and coded each testimony as a unique event.

Table 1 presents the results for All Testimonies in Column 1, and then breaks down the results into two sub-groups: Testimonies by Non-Scientists (Column 2) and Testimonies by Scientists (Column 3).

For all 1350 testimonies in Column 1, 703 (52.1 %) testimonies expressed a view on the GWCC existence question, while 647 (47.9 %) did not. In Table 1, ‘Valid Percent’ is for those testimonies that expressed an opinion on GWCC existence. Among the 703 testimonies with a stance on this question, 598 (85.1 %) stated that GWCC was happening or underway, 89 (12.7 %) were not sure, and only 16 (2.3 %) indicated that there was no GWCC.

The results for non-scientists’ testimonies in Column 2 in Table 1 show a similar picture. For all 598 testimonies by non-scientist witnesses, 341 (57.0 %) did not express a clear stance on the question. Of the 257 testimonies (43.0 %) that clearly expressed an opinion on the question, 214 (83.3 %) indicated GWCC was already underway, while less than 20 % suggested either GWCC was not real or they were not sure if GWCC was happening. These findings are useful because they suggest that it is unlikely that the perceived inconsistencies in GWCC testimonies could be a result of non-scientists testifying before Congress.

Now let us focus on scientists’ views, shown in Column 3 of Table 1. For all 752 testimonies provided by scientist witnesses, 446 (59.3 %) of them clearly expressed a stance on the GWCC existence question, while 306 (40.7 %) did not. Of the 446 testimonies by scientists with an expressed stance on this question, an overwhelming majority (384 testimonies; 86.1 %) stated that GWCC was happening, 53 (11.9 %) were not sure, and only 9 (2.0 %) thought that there was no GWCC. This finding of scientists’ views on GWCC existence is consistent with other recent survey results, reporting that an overwhelming majority of scientists and researchers in the climate field believe that global warming is already underway (Rosenberg et al. 2010).

In examining each testimony statement, we also identified the witness’s view on GWCC cause – i.e., whether GWCC is caused, or partly caused, by human activity. The coded categories included: (a) ‘yes;’ (b) ‘not sure;’ (c) ‘no;’ and (d) ‘no stated stance’ (i.e., witness did not reveal an opinion on this question). The coding results are shown in Table 2.

Table 2 shows a very similar distribution pattern to that in Table 1 of the views across the three groups: All Witnesses (Column 1), the Non-Scientists sub-group (Column 2), and the Scientists sub-group (Column 3). In Table 2, among the testimonies with a clearly expressed view on the cause of GWCC (i.e. “Valid Percent” column), more than three-fourths believed that GWCC was caused, to some degree, by human activity. Importantly, and central to our interest in this research, of the 281 testimonies provided by scientists, 220 (78.3 %) indicated that GWCC was anthropogenic, while 53 (18.9 %) were not sure about the human cause, and only 8 (2.8 %) stated that GWCC was not caused by human activity.

4.3 Types of scientist group and their views on GWCC existence and cause

We discussed the possibility that scientists from different types of organizations might differ in their views about GWCC existence and cause. Recall that we further coded the scientist witnesses into three types by their organizational affiliations (academic, government, and advocacy). Table 3 presents the scientists’ views by these categories on GWCC existence and cause.

Table 1 Views on GWCC existence

Is GWCC happening?	All Testimonies			Testimonies by non-scientists			Testimonies by scientists		
	Frequency	Percent	Valid percent ^a	Frequency	Percent	Valid percent ^a	Frequency	Percent	Valid percent ^a
Testimony with a stance									
Yes	598	44.3	85.1	214	35.8	83.3	384	51.1	86.1
Not sure	89	6.6	12.7	36	6.0	14.0	53	7.0	11.9
No	16	1.2	2.3	7	1.2	2.7	9	1.2	2.0
Total	703	52.1	100	257	43.0	100	446	59.3	100
Testimony without a stance	647	47.9		341	57.0		306	40.7	
Total	1350	100		598	100		752	100	

^a Valid percent is for those who expressed an opinion on GWCC existence

Table 2 Views on GWCC cause

Is GWCC caused by human activity?	All testimonies			Testimonies by non-scientists			Testimonies by scientists		
	Frequency	Percent	Valid percent ^a	Frequency	Percent	Valid percent ^a	Frequency	Percent	Valid percent ^a
Testimony with a stance	333	24.7	78.4	113	18.9	78.5	220	29.3	78.3
Yes	82	6.1	19.3	29	4.8	20.1	53	7.0	18.9
Not sure	10	0.7	2.4	2	0.3	1.4	8	1.1	2.8
No	425	31.5	100.0	144	24.1	100.0	281	37.4	100.0
Testimony without a stance	925	68.5		454	75.9		471	62.6	
Total	1350	100.0		598	100.0		752	100.0	

^a Valid percent is for those who expressed an opinion on GWCC cause

Table 3 Views on GWCC existence and GWCC cause by different scientist groups

Is GWCC happening?	Testimonies by academic scientists		Testimonies by government scientists		Testimonies by advocacy scientists	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Yes	150	84.3	122	85.9	112	88.9
Not sure	24	13.5	19	13.4	10	7.9
No	4	2.2	1	0.7	4	3.2
Total	178	100.0	142	100.0	126	100.0
Is GWCC caused by human activity?	Frequency	Percent	Frequency	Percent	Frequency	Percent
Yes	82	78.1	79	82.3	59	73.8
Not Sure	19	18.1	17	17.7	17	21.3
No	4	3.8	0	0.0	4	5.0
Total	105	100.0	96	100.0	80	100.0

Table 3 shows that a majority of scientists' testimonies, regardless of which types of organizations these scientists were associated with, indicated GWCC was happening and GWCC was caused to some degree by human activity. For the GWCC existence question, among the three types of scientist groups, 88.9 % of the testimonies by advocacy scientists believed GWCC exists, followed by 85.9 % by government scientists, and 84.3 % by academic scientists; for the GWCC cause question, 82.3 % of the government scientist group, 78.1 % of the academic scientist group, and 73.8 % of the advocacy scientist group answered 'yes' to the question of whether human activity is a contributing cause of GWCC. Across all three types of scientist groups, no more than 5.0 % believed either that GWCC was not occurring or that GWCC was not caused by human activity.

4.4 Scientists' views and different party controls of congress

Previous studies suggest that, for reasons such as political ideology and partisanship, Congress under different party controls may have different information mobilization patterns when calling witnesses to testify in congressional GWCC hearings (Fisher et al. 2013a, b; Park et al. 2014). This implies that which party, Democratic or Republican, had a majority in Congress could make a huge difference in the composition of scientist witnesses and the stances they presented on GWCC. In other words, scientists who testified in Republican-controlled Congresses may have quite different views compared to those who testified under Democrat-controlled Congresses.

To examine this possibility, we further classified all scientists' testimonies into two groups under different party controls of Congress: Democratic Congresses (Democratic Party had a majority in both chambers) and Republican Congress (when both chambers were under a Republican majority).⁷ Table 4 shows the results for those scientists' testimonies with an expressed view on GWCC existence or GWCC cause.

⁷ Data for partisan composition of Congress were drawn from official US House and Senate websites. See https://www.senate.gov/pagelayout/history/one_item_and_tasers/partydiv.htm, and <http://history.house.gov/Institution/Party-Divisions/Party-Divisions>.

Table 4 Views on GWCC existence and cause by different party controls of Congress

Is GWCC happening?	Testimony by scientists under Democratic Congresses		Testimony by scientists under Republican Congresses	
	Frequency	Percent	Frequency	Percent
Yes	268	89.3	72	77.4
Not sure	29	9.7	15	16.1
No	3	1.0	6	6.5
Total	300	100.0	93	100.0
Is GWCC caused by human activity?	Frequency	Percent	Frequency	Percent
Yes	154	84.6	48	76.2
Not sure	26	14.3	10	15.9
No	2	1.1	5	7.9
Total	182	100.0	63	100.0

The results in Table 4 show that Republican Congresses were more likely to feature scientists' testimonies with a skeptical view about GWCC than were Democratic Congresses (for "Is GWCC Happening": Chi-Square = 31.011, $p < .01$; for "Is GWCC Caused by Human Activity": Chi-Square = 12.947, $p < .01$). Nevertheless, despite the difference, the majority of the scientists' testimonies, more than 80 % under Democratic Congresses and more than 75 % under Republican Congresses, indicated that GWCC was real and caused to some degree by human activity.

4.5 Scientists' stated policy positions on GWCC

In this last part of data analysis, we examine witnesses' stated policy positions for GWCC. In their testimonies to congressional hearings, witnesses often gave specific policy recommendations or expressed their support for policy initiatives to address GWCC. In our content analysis and testimony coding, we identified what type of policy position was advocated or supported in testimony statements and classified each testimony into one of the following 'policy position' categories: (a) Pro-action Position – including testimonies with policy support or recommendation for climate mitigation or adaptation⁸; (b) Status Quo/Contrarian Position – including those arguing 'do nothing,' 'no policy is needed,' or opposing any mitigation/adaptation policies or initiatives; and (c) Unknown/Undisclosed Policy Position.

The results of the policy positions for All Testimonies, Testimonies by Non-Scientists, and Testimonies by Scientists are shown in Table 5. For all the scientists' testimonies, we further

⁸ While the terms "mitigation" and "adaptation" were not always used during testimony, specific policy proposals can be directly linked to these strategies. Policies that would reduce the amount of greenhouse gas emissions, with the goal of limiting the impact of GWCC at the source of the pollution, are mitigation strategies; policies designed to adapt to the repercussions of GWCC, such as the construction of sea walls in preparation for rising sea levels, are adaptation strategies. While these represent different strategies for addressing GWCC, they were coded as a single category, 'Pro-action,' to identify those who testified before Congress and made policy recommendations that would address GWCC.

Table 5 Stated policy positions

Policy position?	All testimonies			Testimonies by non-scientists			Testimonies by scientists		
	Frequency	Percent	Valid percent ^a	Frequency	Percent	Valid percent ^a	Frequency	Percent	Valid percent ^a
Policy position stated	1032	76.4	92.6	445	74.4	88.8	587	78.1	95.6
Pro-action position	83	6.1	7.4	56	9.4	11.2	27	3.6	4.4
Status quo/contrarian position	1115	82.6	100.0	501	83.8	100.0	614	81.6	100.0
Policy position not mentioned	235	17.4		97	16.2		138	18.4	
Total	1350	100.0		598	100.0		752	100.0	

^a Valid percent is for those who expressed a policy position

break down the results by organizational types in Table 6 and by different party controls of Congress in Table 7.

In Table 5, among all 1350 testimonies, 235 did not express a policy position. Among the 1115 testimonies with a clearly stated policy position, 1032 (92.6 %) of them expressed a pro-action policy position to deal with GWCC. Table 5 also shows that the percent of scientists' testimonies pushing for GWCC policies (95.6 %) is higher than that in the entire testimony population as well as that in the non-scientist witness group (88.8 %).

Table 6 confirms that scientists, regardless of organizational affiliation, were supporting GWCC initiatives, with 94.9 % of the academic scientist group, 99.5 % of the government scientist group, and 92.0 % of the advocacy scientist group endorsing a pro-action policy position.

Table 7 shows that nearly all scientist witnesses (410, 97.6 %) who testified under Democratic-controlled Congresses recommended GWCC policy action. Under the Republican-controlled Congresses there was still an overwhelming majority of scientists' testimonies (130, 89.0 %) urging the lawmakers to take actions, even though statistical tests (Chi-Square = 52.361; $p < .01$) indicated that the percent of scientists' testimonies with a status quo or contrarian position (11.0 %) was significantly higher under Republican Congresses than that under the Democratic Congresses (2.4 %).

5 Discussion and conclusion

There are many social, economic, and political factors that affect the development of government policies. One obstacle that might hinder U.S. legislative action to address GWCC, as often assumed in the information deficit theory, is possibly the confusion, contention, and even opposite perceptions among policy makers about whether scientists are substantially divided in their transmission of GWCC information to Congress. In this study, we set out to examine congressional witnesses', particularly scientist witnesses', views and positions on several important questions regarding GWCC to identify the extent this testimony presents a "divided science." By systematically collecting congressional records on GWCC that cover over 39 years from 1969 to 2007 and using content analysis methods, we provide a quantitative account of what scientists have presented to Congress in their testimonies with regard to their views and positions on GWCC existence, GWCC cause, and their policy preferences.

Our findings illustrate that the level of agreement in the scientific community is reflected in the level of agreement in scientists' testimony to Congress. Specifically, our data indicate that among all the scientists' testimonies with clearly expressed views on GWCC existence, a vast majority – more than 86 % – indicates that it is happening (see Table 1, Column 3). Our data

Table 6 Stated policy positions by three types of scientist groups

Policy preference	Academic scientists		Government scientists		Advocacy scientists	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Pro-action position	205	94.9	210	99.5	172	92.0
Status quo/contrarian position	11	5.1	1	0.5	15	8.0
Total	216	100.0	211	100.0	187	100.0

Table 7 Scientists' policy positions under different party controls of Congress

Policy position?	Testimony by scientists under Democrat Congresses		Testimony by scientists under Republican Congresses	
	Frequency	Percent	Frequency	Percent
Pro-action position	400	97.6	130	89.0
Status quo/contrarian position	10	2.4	16	11.0
Total	410	100.0	146	100.0

also show that among the scientists' testimonies with identified views on whether GWCC is anthropogenic, a great majority of them – more than 78 % — indicates that GWCC is caused to some degree by human activity (Table 2, Column 3). Our findings also demonstrate that an overwhelming majority – more than 95 % – of the scientists' testimonies with clearly expressed policy preferences are supportive of policy actions to combat GWCC (Table 5, Column 3).

Even when Congress was controlled by the Republican Party, there is still a supermajority suggesting that GWCC is real (77.4 %; see Table 4, Column 2) and anthropogenic (76.2 %; see Table 4, Column 2) and endorsing government policy action toward GWCC (89 %; see Table 7, Column 2).

Recent surveys have shown mounting evidence that most GWCC scientists agree that global warming is real and human activity is contributing to GWCC (Oreskes 2005; Doran and Zimmerman 2009; Anderegg et al. 2010; Rosenberg et al. 2010; Cook et al. 2013). Our research presented here not only supports these previous studies, but further demonstrates that the general climate science agreement on GWCC, when transmitted to Congress, is not substantially divided; rather, the near-complete scientific agreement in the climate science community has been consistently presented to Congress.⁹

Certainly, there will always be scientific debates and technical unknowns associated with any science. Reaching a one hundred percent certainty or expecting no disagreement among scientists regarding climate science are not only impossible (as reflected in this study by the small percentage of GWCC testimonies that argue it is not occurring), but also undesirable. Effective policy to address GWCC will require recognition of certain uncertainties and different opinions associated with the issue, but more importantly it will also require the courage to face the facts by acknowledging, incorporating, and legitimizing supermajority scientists' views and stances on GWCC.

While there is no scientific definition of the term “consensus”, we observe considerable agreement in congressional testimony on both the existence of GWCC and an anthropogenic component of its cause. The degree of agreement is largely consistent across partisan control of Congress and across the types of scientist group (government, industry, or university). The similarity of these levels of agreement to that observed in the recent surveys of scientists suggests that any changes in the level of agreement among legislators are not because of a lower level of agreement in the scientists' testimonies themselves.

Our findings indicate that the information deficit thinking is flawed to the extent it relies on the uncertainty expressed in hearings to be greater than that in the scientific

⁹ While this study focused on committee hearings specifically on GWCC, it is possible that contrary positions on GWCC might be more commonly found during hearings that were excluded from this examination because they were not specifically on GWCC. This possibility indicates an additional avenue for future research.

community itself, and possible explanations for policymakers' contention must be based on something other than a lack of knowledge or divided scientific information. With the findings presented in this study, future research attention can be turned to pursuing a better understanding of how alternative explanations, such as business interests, partisan predispositions, and political ideology, shape the views of policymakers. Several recent studies (see Fisher et al. 2013a, b; Park et al. 2014) point to the right direction for future research. For example, Fisher et al. (2013b) provide an explanation for the political divide and polarized policy opinions in congressional GWCC debate; their study also unpacks the specific component of the debate and analyzes the nuanced polarization and politicization dynamics of congressional GWCC activities in recent years (while our study here focused on the period of the early years from 1969 to 2007).

There are also several other directions in which future research can proceed. The limited information on the GWCC congressional hearing witnesses is sufficient for a preliminary investigation like this, but it warrants further examination. Detailed assessment over a shorter period of time could look at the role of multiple affiliations, more nuanced categorization of scientists by field, or repeated appearances. These are all likely interesting avenues for future research on a more focused sample. Similarly, this article aggregated the coverage of GWCC across time. There may be important differences in who is appearing, what they say across time and how scientist witnesses' views evolve over time. Breaking the sample into eras could result in interesting patterns emerging. This is an exciting possibility for future research. Moving past the information deficit model shifts the research in these and other interesting directions.

Acknowledgements The material used in this study is based upon research conducted by the Institute for Science, Technology and Public Policy in the George Bush School of Government and Public Service at Texas A&M University and supported under Award No. award NA04OAR4600172 by the National Oceanic and Atmospheric Administration (NOAA), U.S. Department of Commerce. The statements, findings, conclusions, and recommendations are those of the authors and do not necessarily reflect the views of the National Oceanic and Atmospheric Administration or the Department of Commerce. We would like to thank the following people for their assistance: Carol Goldsmith, Ivy Cui, Jessie Wang, and Charles Lindsey. We would also like to thank the anonymous reviewers for their insightful comments and suggestions.

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