

More than entertainment: YouTube and public responses to the science of global warming and climate change Social Science Information I-32 © The Author(s) 2014 Reprints and permissions: sagepub.co.uk/journalsPermissions.nav DOI: 10.1177/0539018414554730 ssisagepub.com



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### Abstract

The public receives and presents science-related information on global warming and climate change in many forms, but little is known about how this information is conveyed through the Internet. More specifically, very few studies have considered YouTube videos focusing on climate change. This study provides a better understanding of how this type of information may be disseminated through several levels of analysis. For this purpose, the exact narrative for the 10 most popular videos about climate change was first established by concentrating particularly on the presentation of the science of climate change. Then the public's responses to and engagement in each video were examined through a semantic analysis of comments on the video. The results indicate that, regardless of the narrative, science-based comments dominated, but often discussed climate change in general instead of specific videos to which they were attached. In the absence of gatekeepers, YouTube users rode the coattails of popular videos about climate change and addended the videos' messages by highlighting evidence of weak, strong, or politicized science.

#### **Keywords**

climate change, global warming, politicized science, science communication, semantic network analysis, social network analysis, webometrics, YouTube

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#### Résumé

Le public reçoit et présente des informations d'ordre scientifique sur le réchauffement global et le changement climatique sous diverses formes, mais on sait peu de choses sur la manière dont ces informations sont véhiculées par l'Internet. Pour être plus précis, très peu d'études se sont intéressées aux vidéos de You Tube portant sur le changement climatique. A travers différents niveaux d'analyse, cette étude tente de faire mieux comprendre la façon dont ces informations peuvent être disséminées. A cet effet et en premier lieu, le contenu narratif exact des 10 vidéos les plus populaires sur le changement climatique a été recensé en se concentrant en particulier sur les présentations d'ordre scientifique du changement climatique. Puis les réponses du public visionnant les vidéos ont été examinées à travers une analyse sémantique des annotations sur les vidéos. Les résultats indiquent que, indépendamment du contenu narratif, les annotations d'ordre scientifique dominent, mais qu'elles portent souvent sur le changement climatique en général plutôt que sur les vidéos spécifiques auxquelles elles se rattachent. En l'absence de contrôle d'accès, les utilisateurs de You Tube profitent des vidéos les plus populaires sur le changement climatique pour faire passer des messages qui mettent l'accent sur des preuves d'ordre scientifique, que ce soit des données de vulgarisation scientifique, des données de la recherche scientifique, ou des données à visée politique.

#### Mots-clés

analyse de réseau sémantique, analyse de réseau social, changement climatique, communication sur la science, réchauffement global, science politisée, webométrie, You Tube

This study examines communication about climate change to better understand how the public discusses the issue in a milieu largely devoid of authority figures or gatekeepers, namely YouTube videos and the comments posted to such videos. There are no factchecking restrictions nor any peer-review process.<sup>1</sup> This is remarkable in that YouTube has more than four billion video views a day, is the third most-visited website in the world, and has more than 72 hours of videos uploaded to it every minute (Pew Research Center, 2012). This absence of authority figures, allied with the complete freedom to communicate and disseminate information, raises several important questions: What are the implications of information asymmetry in scientific phenomena? Is there a clear pattern showing how people respond to claims about the science of climate change? How do videos challenging the science of climate change generate supporting comments or counterarguments by the scientific (or science-referencing) community? To address these questions, this study builds on previous studies such as Hansen (2011) and O'Neill and Boykoff (2011) by providing a crucial bridge between the presentation of climate change on the Internet with subsequent discussions of climate change by the public. Given polarized views on the science of climate change among the public, the likelihood of politicized science, and the public's increased reliance on the Internet as a source of information, there is an urgent need to pay attention to these issues.

The Internet, with its rapid and potentially universal dissemination of information, has dramatically altered the traditional media landscape. Although Internet-based information is generally misleading (Garrett, 2011; Stempel et al., 2007),<sup>2</sup> randomly found (Williams, 2011), and helps fragment the traditional media system (Nisbet, 2009), it also provides increased opportunities for the public – or at least that segment of the public that interacts via the YouTube platform – to interact through multidirectional communication among its video submitters and viewers (Bou-Franch et al., 2012; Jung et al., 2014). These interactions are important for three reasons: First, they redefine traditional media in the sense that discussions about an issue no longer occur with one's self-selected peers (e.g. at the coffee shop, around the water cooler, or over the dinner table) but with any member of the YouTube community. Second, they allow for the nonlinear transfer of information; that is, users can direct questions.<sup>3</sup> Third, they build on recent and largely exploratory research acknowledging YouTube videos as a source of information and a creator of visual memes (Smith & Joffe, 2012; Xie et al., 2011). In other words, YouTube offers much more than traditional media by being accessible and popular as a source of visual as well as written information, and most importantly, users can update and alter the narrative of information in the video by providing comments.

The concept of politicized science is crucial to this study as it is the primary mechanism for the discounting of climate-change-related science. As a primer, science itself may be politicized (e.g. a study may be designed to substantiate a particular political position), objective scientific evidence may be politicized by its authors (e.g. making claims inconsistent with the evidence for political purposes), scientific processes may be politicized by non-scientists (e.g. scientific evidence may be misconstrued by corporate or government actors for political gain), and/or politicians or other public figures may politicize otherwise objectively investigated, reported, and interpreted evidence (e.g. politicians may selectively consider or discuss scientific evidence for the purpose of supporting their political or policy objectives) (Bolsen et al., 2014). The dominant feature of politicized science is that science and the scientific method are eclipsed by a focus on elected officials, interest groups, or policies. In the case of climate change, several of the most popular videos (videos this study focuses on) are critical of the science of climate change, and this popularity may be attributed to their successful politicization of science.

Even acknowledging the connection between science and politics and various obstacles with incorporating scientific advice into the policymaking process (Cho et al., 2012; Pielke, 2006, 2007; Schneider, 2000; Union of Concerned Scientists, 2008), it remains unclear why videos that politicize science are popular or how the public reacts to their scientific and/or politicized content. Preliminary findings about YouTube content show that the public may be mobilized around climate-change-related issues (Porter & Hellsten, 2014), reflecting the impact of highly publicized and discussed news such as Climategate or extreme weather (Leiserowitz et al., 2013; Myers et al., 2012), the strength of one's personal ideology (McCright & Dunlap, 2011; Zia & Todd, 2010), one's preexisting beliefs about climate change (Myers et al., 2008). In addition, the media make limited but pejorative references to climate models (i.e. geophysical models) (Akerlof et al., 2012), or personalize or dramatize climate change instead of discussing it as the output of objective science (Boykoff & Boykoff, 2007). Echoing Schneider's (2000) observations, we believe that there has been no change in such media-based practices.

Both science-oriented (politicized or not) and non-science-oriented YouTube videos are likely to impact public views about climate change (Boykoff & Boykoff, 2007). Therefore, this study does not discriminate against nor target particular types of videos. In addition,

such restrictions would be premature because of the gap in the literature on this subject and because of the complexities and subtleties in politicized science. This study, thus, offers an exploratory examination of whether the post-video discussion forum acts as a validation check on science-related content. More specifically, the study addresses the question of whether post-video discussions are attuned more to 'science' when the video employs some type of science-oriented (politicized or not) narrative, or whether YouTube commenters discuss climate change in a random manner, or something else entirely. In this regard, the study provides a content analysis of the most popular YouTube videos related to climate change by employing Nisbet's (2009) structure for climate-change-related narratives. We then examine how climate change is discussed among users across these narratives through both quantitative and qualitative analyses. Only through these efforts can we sufficiently understand how YouTube users contribute to the discussion of climate-change-related science.

## Narrative identification

The unit of analysis is the YouTube video, specifically the 10 most-viewed videos when conducting a keyword search for 'global warming' on the YouTube website. We focus on these videos because they are popular, because comment traffic is high, and because a search for 'global warming' rather than 'climate change' (or both sets of terms simultaneously) is expected to yield a more controversial response by the public (Schuldt et al., 2011; Whitmarsh, 2009). Table 1 provides the details for these 10 videos in terms of their style, video quality (professional or not), year of posting, view numbers, and number of comments leading up to November 2011.<sup>4</sup>

This study applies the findings of Nisbet's (2009) meta-analysis to provide the first ever mixed-methods analysis of YouTube videos. A total of 10 relevant narratives were identified:

- climate change/global warming ... is economically costly;
- is a shared moral challenge for everyone;
- is a solvable challenge;
- has unavoidable consequences (i.e. fatalism);
- is a matter for scientists and experts;
- is still debated by scientists;
- has been blown up out of proportion by scientists;
- has been blown up out of proportion by politicians;
- reveals problems with science and expertise in policymaking;
- and is a game among elites.

To limit bias and establish a reliable assessment of each video's narrative(s), we employed 17 undergraduate students at a university in Chicago to assign narratives to each of these videos. These coding assignments are presented in Table 2 for the 10 most-viewed videos

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Video number	-	2	£	4	5	6	7	8	6	01
Title	Chart	Lord Monckton	Human art	National Geographic	Will Ferrell	Polar bear animation	Blue Man Group	Global warming scam!	Suing Al Gore	Kiribati
Brief description	A risk analysis shows a need for action.	Copenhagen and other international laws intend to trump domestic laws.	Hundreds of nude people pose on the glacier as 'human art' and to attract attention to the issue.	Provides an overview of anthropogenic global warming.	Spoofs President Bush and the issue of global warming.	Polar bears talk about possible causes of climate change.	The Blue Man Group expresses its concerns about global warming.	A monologue criticizes Al Gore and weak science.	The Weather Channel founder announces his intentions to sue Al Gore for	Provides an overview of rising sea levels and interviews with Kiribati residents
Style	Lecture	Lecture	Documentary	Documentary	Comedy	Animated PSA	Performance art	Lecture	Interview	Documentary
Professional video quality	٥N	Yes	Yes	Yes	Yes	Yes	Yes	°N N	Yes	Yes
Year posted Number of views <sup>a</sup>	2007 5 million	2009 2.6 million	2007 I.7 million	2007 I.5 million	2007 I.2 million	2007 I.I million	2006 826,000	2007 800,000	2008 705,000	2009 679,000
Number of comments <sup>a</sup>	30,000	9,700	7,500	78,000	1,600	4,200	8,800	54,000	53,000	2,200

Table 1. Descriptions of the 10 most-viewed videos on 'global warming' on YouTube.

<sup>a</sup>Views and Comments as of November 2011.

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Video number	_	2	ŝ	4	5	6	7	8	6	10
Title	Chart	Lord Monckton	Human art	National Geographic	Will Ferrell	Polar bear animation	Blue Man Group	Global warming scam!	Suing Al Gore	Kiribati
Economically costly A shared moral challenge	>>	>>	>	>		>	>			>>
A solvable challenge	> `		>	>			> >			> >
consequences)	>						>			>
Expertise needed Scientifically unresolved Buraviov scientists	>							> >	> >	
Runaway scienciscs Runaway politicians		>						> >	> >	
Science policy problems	>	> `	>		>			>	>	
Elite games Presence of broad		>						>	>	
categorization? Moral challenge/ call for	Yes		Yes	Yes			Yes			Yes
action	}		}	8			8			8
Science problems & elitism	Yes	Yes						Yes	Yes	
Not categorized					Yes	Yes				
			-							

Table 2. Coding assignments for each of the 10 videos using Nisbet's (2009) narratives.

Note: 🗸 is assigned if at least 70 % or more respondents selected the respective narrative category.

related to global warming, and we assigned an affirmative code (noted with a check mark in Table 2) if at least 70 percent or more respondents selected the respective narrative category.<sup>5</sup> We recognize that these narratives may not perfectly differentiate between different meanings prevalent in the climate debate. For example, the idea that climate change would be 'economically costly' may refer to the argument that changing weather patterns would have direct effects or to the argument that efforts to prevent or mitigate climate change would entail huge costs. Both interpretations/observations are appropriate and address economic costs one way or another.

This process of narrative assignment revealed several patterns.

First, no video contained the frame 'expertise needed'. Although this frame was not expected to be present for those videos arguing against scientific or policy efforts to address global warming, such as Lord Monckton, Global warming scam!, and Suing Al Gore, it was surprising that it was also absent from all remaining videos, even those that highlighted real or potential effects of global warming, such as Chart, National Geographic, Polar bear animation, and Kiribati. This suggests that, for videos arguing against the science of climate change, scientists and experts were viewed as being a part of the problem, a suggestion that was compounded by several other narratives. More specifically, around half of all videos describing global warming as problematic because of the science and a lack of expertise presented narratives describing scientists and politicians as blowing the issue of global warming out of proportion. This is apparent for three videos that argued on one level or another against evidence of global warming (Lord Monckton, Global warming scam!, and Suing Al Gore), and may not simply be a policy problem or a matter of alarmist scientists and politicians, but more a matter of perceived elitism, because global warming is also presented as a battle among elites in only these three videos. This represents a continuation of some of the earliest observations about non-value-neutral scientists (Lindblom, 1959; Weinberg, 1972), as well as other problems with the process in which scientists convey information to Congress (Pielke, 2006, 2007; Schneider, 2000; Union of Concerned Scientists, 2008).

Second, all of the videos employed the narrative 'shared moral challenge' except for Will Ferrell's parody of President Bush, *Global Warming Scam!*, and *Suing Al Gore*. Five of those videos presenting the 'moral challenge' narrative also conveyed global warming as representing a 'solvable challenge'. This combination of narratives implies the greatest overlap among narratives for these 10 videos, conveying a sense that people have the capacity and are morally bound to address the problem of global warming. In addition, three videos reflected the fatalism narrative. This combined solvable-but-unavoidable narrative instilled in the viewer a sense that taking no action would produce unavoidable consequences (*Chart, Blue Man Group*, and *Kiribati*).

In general, this sample of the most popular climate-change-related YouTube videos can be divided into three broad categories: videos calling for action to address global warming by presenting the problem as a moral challenge, a solvable challenge, and/or as a looming threat that must be addressed; videos calling for action to address deficiencies in the science and/or politics of global warming, possibly because of perceived elitism; and videos with an unsystematic narrative presence, such as *Will Ferrell* and *Polar bear animation*. These broad categories are included at the foot of Table 2 and are used henceforth.

### Semantic analysis of comments

Given these narratives, we focus our attention on how people respond to claims about the science of climate change, particularly how YouTube users comment on videos that challenge the science of climate change.

The semantic analysis began with determining which terms in comments for YouTube videos qualified as 'science' content. With the FullText software package,<sup>6</sup> one thousand of the most recent comments were compiled for each video.<sup>7</sup> During this process, Webometric Analyst 2.0 was employed to retrieve some textual and usage data from YouTube.com (Thelwall, 2012). The collected comments were cleaned for any misspelling and symbols were converted to text (e.g. '+' to 'plus' and '%' to 'percentage'), and single-word structures were created from the most common two-word structures (e.g. 'climatechange' from 'climate change' and 'globalwarming' from 'global warming') to enable the convergence of iterated correlations (CONCOR) analysis. Details of the CONCOR analysis are provided below, and Table 3 presents the 50 most frequent comment-based terms for each video.<sup>8</sup>

The following shared terms were observed across comments for nearly all of the 10 videos (from the 50 most common terms): 'American' (present except for *Suing Al Gore*), 'cause' (present except for *National Geographic*), 'climate', 'climate change', 'CO2', 'earth' (present except for *Global warming scam!*), 'global warming', 'look', 'people', 'science' (present except for *Kiribati*), 'scientist', 'time', 'warming' (present except for *Kiribati*), and 'world'. However, comments for each video also presented many other terms offering greater insights into precisely how the science of climate change could be framed. Invoking Bolsen et al. (2014), our analysis focused thus on whether scientific evidence was claimed to have been misconstrued by political actors for some political gain. That is, do comments invoke politicized science? And, more importantly, if and when politicized science is invoked, is it to bolster or challenge the science of climate change?

For all videos except one (*Polar bear animation*), comments referenced both the science of climate change and politicized science. Looking once again at Table 3, the most common terms were 'Al Gore' (referring to Al Gore's co-directing efforts for the documentary An Inconvenient Truth)<sup>9</sup> and 'government', but there were several others, including 'Bush' (referring to former president George W. Bush), 'president', 'NASA' (National Aeronautics and Space Administration), 'NOAA' (National Oceanic and Atmospheric Administration), and 'IPCC' (Intergovernmental Panel on Climate Change). In addition, a set of popular terms typically used pejoratively to describe (correctly or otherwise) ideological differences was observed: 'liberal', 'communist', 'Hitler', and 'rightwing'. Key interest groups in the form of 'Koch brothers' and 'Greenpeace' were mentioned in comments on the videos Chart and Human art, respectively. Further, comments referenced two specific scientists involved in the climate-change discussion: 'Muller' (Richard Muller), who initially raised some concerns about Michael Mann et al.'s (1999) 'hockey stick' work, and 'Michael Mann' himself.<sup>10</sup> In short, the 50 most common terms from comments on these 10 videos indicate at least moderate discussion of politicized science.

		מווחסר להז בווחסר	ר וו בלחבוור רסוווי	ווובוור-חמצבח רבו וווי	א מאבת ווו במרוו					
Video no.	-	2	ε	4	5	6	7	8	6	10
Title	Chart	Lord Monckton	Human art	National Geographic	Will Ferrell	Polar bear animation	Blue Man Group	Global warming scam!	Suing Al Gore	Kiribati
_	PEOPLE	WORLD	GLOBAL WARMING	PEOPLE	GLOBAL WARMING	POLARBEAR	GLOBAL WARMING	TEMPERATURE	RE	CHANGE
7	CLIMATE	AMERICA	PEOPLE	CLIMATE	BUSH	GLOBAL WARMING	CLIMATE	CO2	Your Kids Arent Special	PEOPLE
e	CLIMATE CHANGE	PEOPLE	AMERICA	RE	PEOPLE	CAUSE	CLIMATE CHANGE	DATA	EMAIL	CLIMATE
4	EARTH	GLOBAL WARMING	WORLD	NIGHT VERSIONN	LOL	ICE	DATA	WARMING	CLIMATE	LOOK
5	TIME	LORD MONCKTON	HUMAN	CLIMATE CHANGE	WORLD	PEOPLE	CO2	CLIMATE	SCIENCE	EARTH
6	WORLD	CO2	LOOK	WORLD	CO2	HUMAN	SCIENTIST	GLOBAL WARMING	FRUMI	WORLD
7	GLOBAL WARMING	LOOK	OIL	SCIENCE	RE	НАТ	PEOPLE	ICE	BUDDY	SEALEVEL
8	NIGHT VERSIONN	CLIMATE CHANGE	ICE	TARDED CHANNEL COPIER	LOOK	EARTH	TIME	RECORD	PEOPLE	RISE
6	WARMING	SCIENTIST	CO2	TIME	stop Global Warming08	CLIMATE CHANGE	TEMPERATURE	TIME	TIME	HUMAN
0	PLANET	GOVERNMENT	SCIENTIST	GLOBAL WARMING	BELIEVE	LAME	WARMING	GLOBAL	LAUREL BUSH	GLOBAL WARMING
=	HUMAN	CLIMATE	GREENPEACE	ICE	EARTH	C02	NIGHT VERSIONN	INCREASE	WORLD	VIDEO
12	DATA	BELIEVE	TIME	OIL	AMERICA	SCIENTIST	CAUSE	WARM	IPCC	ISLAND
13	OIL	TIME	EARTH	LAUREL BUSH	ΠE	VIDEO	SCIENCE	CAUSE	CLIMATE GATE	TIME
4	ENERGY	GUY	GLACIER	LOOK	SCIENTIST	WORLD	WORLD	SCIENCE	CLIMATE CHANGE	KIRIBATI
15 16	CO2 RE	OBAMA GLOBAL	NAKED PLANET	SCIENTIST CO2	GLOBAL LIBERAL	BEAR CLIMATE	ICE RISE	COOLING FERRETT78	AGW SCIENTIST	CAUSE RE

ment-based terms used in each of the 10 videos Table 3. Ranking of the ton 50 most frequent com

(Continued)

Table	3. (Continued									
Video no.	-	7	£	4	5	6	7	ø	6	01
Title	Chart	Lord Monckton	Human art	National Geographic	Will Ferrell	Polar bear animation	Blue Man Group	Global warming scam!	Suing Al Gore	Kiribati
17	LIFE	COUNTRY	FUEL	NAZI	SHIT	LOL	ALGORE	NASA	MEAN	YOUTUBE
18	BELIEVE	CAUSE	GOVERNMENT	TEMPERATURE	FUNNY	WARMING	CARBON	SOLAR	WARMING	ICE
6	TAMPADOC64	OIL	HUMAN RIGHTS VIDEOST	YOUR KIDS ARENT SPECIAL	CLIMATE	ГООК	EARTH	CARBON	CAUSE	FUCK
20	SCIENTIST	ALGORE	VIDEO	AGW	TIME	RE	OCEAN	Your Kids Arent Special	NATURAL	SCIENTIST
21	DENIER	SCIENCE	BELIEVE	ткү	TALK	HAPPEN	RECORD	EARTH	READ	CLIMATE CHANGE
22	ICE	LORD	NATURAL	OCEAN	WARMING	TIME	SEALEVEL	RE	LUGHEAD BUSH	NATURAL
23	CHANGE	RE	GLOBAL	RANDOM LAUGHING MAN	POWER	AMERICA	GLOBAL	CHANGE	PHILJONE	OCEAN
24	MEAN	MEAN	SPAM	раү	ALGORE	CARE	<b>CRISTOP5</b>	CLIMATE CHANGE	EVIDENCE	HAPPEN
25	ткү	SIGN	WARMING	HEAT	CAUSE	AGE	ENERGY	LITTLE	COOLING	BELIEVE
26	SCIENCE	CARBON	CAUSE	OZCHECKM8	CLIMATE CHANGE	SCIENCE	LOOK	green House	LOOK	LIVE
27	BUCHEDDA	READ	HAPPEN	ALGORE	FUCKING	STOP	GLACIER	MROTL CHAMP	TEMPERATURE	MOVE
28	LOOK	VIDEO	STUPID	EARTH	STUPID	TEMPERATURE	TROLL	SEA	RECORD	PLANET
29	VIDEO	TREATY	LIVE	WARMING	VIDEO	SPECIE	DENIER	MIAW	RISE	WATER
30	COMMENT	EVIDENCE	LOL	AMERICA	WILLFERRELL	FUNNY	COOLING	SCIENTIST	WATER	CO2
31	COURSE	PLEASE	COUNTRY	WATER	FUCK	PERCENT	LIE	EVIDENCE	GLOBAL WARMING	GOVERNMENT
32	GLOBAL	EARTH	STOP	LITTLE	NAZI	REAL	SCIENTIFIC	LOOK	C02	SHIT
33	POWER	DATA	CHANGE	RESEARCH	OBAMA	SUN	AMERICA	AGW	DATA	LAND
34	AMERICA	POWER	DELETE	TALK	RECORD	CHANGE	NATURE	AMERICA	DECADE	SEA

Table	3. (Continued)	(								
Video no.	_	2	٤	4	5	9	7	8	6	01
Title	Chart	Lord Monckton	Human art	National Geographic	Will Ferrell	Polar bear animation	Blue Man Group	Global warming scam!	Suing Al Gore	Kirib ati
35	QUESTION	TRY	ENERGY	IPCC	ACTUALLY	GLOBAL	PLANET	DAY	LUGHEAD	WORD
36	CARBON	ENERGY	MONEY	LIE	ICE	ткү	LEVEL	PEOPLE	WARM	FUCKING
37	REAL	EXPERT	REAL	PEADO	READ	BELIEVE	AGW	EFFECT	DENIER	STOP
38	SOLAR	NATION	SCIENCE	IDIOT	HITLER	MELT	EVIDENCE	LEVEL	LIE	COMMENT
39	YE	TALK	WHALE	SHIT	LOVE	LIFE	MARCH	PLANET	PAST	LLE
40	NIGHTY	ткитн	LIFE	VIDEO	PRESIDENT	ANIMAL	GROW	RESULT	MICHAEL MANN	LIFE
41	KOCH	COMMUNIST	FREE	IMPACT	SCIENCE	SAD	LAST	DECADE	NATURAL	AGE
	BROTHER						CYNIC STANDING		DISASTER	
42	MULLER	COMPANY	READ	SEA	TEMPERATURE	MAYBE	REAL	PAST	POST	AMERICA
43	CAUSE	PLANET	RESEARCH	CARBON	ткү	TALK	CHANGE	SATELLITE	REPORT	LOL
44	GOVERNMENT	ACTUALLY	GREEN	GOVERNMENT	AQUA TRASK	FUCK	NOAA	YE	TREND	CHANNEL
45	NMO	HUMAN	MELT	YOURSELF	COOLING	PLANET	PRAIR LED OGGED	DROUGHT	ткү	DIE
46	READ	INFORMATION	ALGORE	GLACIER	MPHELLO	POPULATION	MEAN	HEAT	CHANGE	CHECK
47	STOP	INTREPIDORATOR	CLIMATE	POST	NUCLEAR	NATURAL	PAPER	MEAN	CHECK YOUR SOURCE	EFFECT
48	TEMPERATURE	WARMING	MEAN	YOUTUBE	RIGHTWING	PAST	PAST	IPCC	DROUGHT	UTTLE
49	WRONG	JOB	PORN	COMMENT	DATA	TRUE	INCREASE	SUN	REAL	MEAN
50	AGREE	RESEARCH	AGW	<b>ENVIRONMENTAL</b>	NATURE	COMMENT	TAX	WORLD	HAPPEN	NATURE
	BILLION	RISE	CARE	MONEY	PERCENT	EXTINCTION			MILLION	
	EVIDENCE		COOLING	RECORD	SCIENTIFIC	LIVE			SCIENTIFIC	
	RESULT		IDEA		TAX	STUPID			SHITFIRE	
			POWER							

To verify the presence of politicized science in comments, we first assessed the connections between the most popular terms used in each video's comments. For this, a CONCOR analysis of the 50 most frequently used words in comments for each video was conducted.<sup>11</sup> CONCOR is a procedure that partitions words into positions based on structural equivalence (Wasserman & Faust, 1994). For example, two parents do not need to have any blood ties to each other to be structurally equivalent, but can be regarded as connected because they have a common set of blood linkages to their children in the family system. That is, the CONCOR-based partition generates subsets of the original set of words, each of which contains words that have similar connections with other words in the text. FullText and CONCOR have been used together with great success,<sup>12</sup> but greater caution has been taken here than in previous YouTube studies (e.g. Lee & Park, 2013; Lim & Golan, 2011; Thelwall et al., 2012) to determine how science-related statements were politicized. Basically, we were not relying solely on quantitative methods but wanted to take into consideration the content of relevant samples of text as well. This is absolutely crucial, as the following three comments made in response to the YouTube video *Chart* show, for example, variance in the discussion about climate change:

- (A1) [To a specific YouTube user], *There are ZERO frauds committed by environmentalists. Go watch the video on the Koch brothers and how they have funded MILLIONS of dollars into LIES about AGW and silenced scientists and activists.*
- (A2) For me, I will go with scientists over global warming deniers.
- (A3) Here is an even bigger scandal than ClimateGate: [Web address] Scientists said climate change sceptics proved wrong ... After all the research was done and proved that there has been no temperature increases in 13 years, Prof Muller of UC Berkley makes a fake graph and a bogus release claiming this research should end skepticism Actually the results of the research should massively increase scepticism. AGW IS FRAUD.

All three comments include the term 'scientist', but the content of the first two provides support for the science of global warming, whereas the third claims the science to be fraudulent. What was required of us, therefore, is a two-step process. First, we had to identify clear semantic correlations between the relevant terms, and then we had to examine those comments which contained these terms to determine whether there is evidence of politicized science. Previous studies based on CONCOR have rarely delved into the latter, qualitative analysis, but have generally cast blanket descriptions over clusters of correlated terms. To remedy this deficiency, the present study combines the strongest attributes of semantic network analysis with traditional discourse analysis in order to fully understand the public's reactions, or at least that segment of the public using YouTube.

Figure 1 presents the CONCOR-based approach for the video *Chart*, where nodes are represented by the 50 most frequently used terms/phrases in the video's comments. Lines and thickness of lines between nodes show co-occurrence and frequency of



Figure 1. CONCOR for Chart (video 1).

co-occurrence, respectively.<sup>13</sup> A group of terms/phrases that have a relatively higher internal connectedness constitutes a cluster. In other words, words belonging to the same cluster have more similar connections with neighboring words than other distant words in the different cluster. As shown in the figure, 'science' and 'scientists' were connected to what can be described as apolitical terms, with the former grouping with 'data' and the latter, with 'evidence' and 'temperature'. This finding is particularly useful because it yields insights into the tie strengths of words classified according to their interaction types. A sample of actual comments containing these combinations of terms for the video *Chart* (video 1) is as follows:

- (B1) [To a specific YouTube user] I DO in fact understand the science and I know that there are many honest scientists who are on this fraud train only as a passenger. It doesn't change the fact that this is a total fraud; a manipulation of data to appease the money train fee.
- (B2) [To a specific YouTube user] *My dearest Dolt... if you [knew] anything about science you would know that they are held to the FOIA when they provide data to any government agency. Second, my foolish drone, the oil industry has funded this fraud since the beginning ....*

- (B3) [To a specific YouTube user] *First of all there is a LOT of evidence that mankind is warming the planet ... [T]hat's why the VAST majority of climate scientists agree that AGW is happening. Yes, the Earth's climate is constantly changing due to a large variety of reasons ....*
- (B4) [To a specific YouTube user] So you are making a claim that would not even hold up in court. These emails you say are evidence of the scientists' perjuring themselves. The deniers don't have the science so they resort to this kind of attack ....
- (B5) Evidence impacts of climate change series for those interested: Scientists sound alarm over Southern Ocean warming. New research shows the Southern Ocean is storing more heat than any other ocean in the world. The study carried out by Tasmania s Antarctic Climate and Ecosystem centre has found that carbon dioxide levels in the Southern Ocean will be corrosive to some shellfish by 2030 if current trends continue. Australia ABC News Australia29 November 2011.
- (B6) [To a specific YouTube user] my god you're stupid. If there was evidence from an overwhelming majority of scientists documenting something [to prove] their case and rationale for their consensus, then you would be an idiot to not prepare for it, but the vampires, dragons, and zombies aren't going to come knocking any time soon as [they're] not real, but if they did get you, it's fair to assume the human race has lost another non-contributing zero.

Three of these comments provide clear evidence that the science of climate change was politicized in many ways: B1 and B4 claimed that the science was fraudulent, with the former pointing out that there was an incentive for such fraud to generate research funding. B2 referred to the role of the oil industry in challenging scientific claims. The remaining three comments (B3, B5, and B6) referred to the science as a fact, and B6 was particularly harsh in its attack on another commenter who challenged climate science. This sample of comments reveals that the discussion focuses in a significant way on how scientists, politicians, and private interests are all involved in climate change. This result is all the more remarkable in that such comments followed a video that was not aligned in any way but simply described the outcomes of four different scenarios in the form of a risk analysis.

Remarkably, these patterns were consistent across the spectrum of comments for the remaining nine videos (see Appendix 2), whether such comments were selected from CONCOR-generated clusters that included 'science' and 'evidence', 'scientist' and 'data', or some other combination of science-oriented terms. Table 4 presents samples of comments made for each video but which invoke science on some level.<sup>14</sup> Each of the combinations of terms was based on CONCOR-derived clusters containing the terms 'science' and/or 'scientist'. That is, these clusters were expected to be least directly connected to aspects of science, politicized or otherwise, as discussed earlier.

Based on this sample, politicized science was rampant across all comments. Across all videos, persistent references were made to the role of both public and private interests in manipulating the science of climate change through incentives for research funding; there were multiple claims that the science upholding the case for anthropogenic climate

Video no. / title	Science keyword I	Science keyword 2	Sample comment
l Chart	Science	Data	[To a specific YouTube user] I DO in fact understand the science and I know that there are many honest scientists who are on this fraud train only as a passenger. It doesn't change the fact that this is a total fraud; a manipulation of data to appease the money train fee.
2 Lord Monckton	Science	Evidence	Don't get me wrong, believing nothing the authorities say is JUST as stupid as believing everything they say The real question is, who is giving the most accurate evidence and/or who is being deceptive. In this case, Lord Monckton is selling snake oil. I watched a video where he tries to explain that agreeing with the majority of published science would be an appeal to authority fallacy which is demonstrably false.
3 Human art	Scientists	CO2	Wow, where the hell do you get your information? Scientists cannot even agree whether CO2 is a source or result of the problem. You're a nut and you're obviously only interested in disseminating misinformation. There are various hypotheses, but they are in relation to exactly what effects we will see and how fast they will occur - not whether or not AGW exists. And you call me the fool.
4 National Geographic	Science	Research	[To a specific YouTube user] The US government spent 79 billion on climate research and technology since 1989; 3,500 times as much as anything offered to sceptics. It buys a bandwagon of support, a repetitive rain of press releases and includes PR departments of institutions like NOAA, NASA, the climate change Science Program, and the Climate Change Technology Program. The 79 billion figure does not include money from other western governments or private industry and is not adjusted for inflation.
5 Will Ferrell	Scientist	Data	A new study in the peer reviewed science journal, Remote Sensing, has [found] that United Nations computer models may be incorrect in overstating the amount of global warming that will occur in the future. James M. Taylor says it would be wise for the media-elected officials and climate scientists to recognize the huge discrepancy between global warming predictors and NASA's satellite data.
6 Polar bear animation	Science	Temperature	Climate change in the news: Fjords Contribute to Melt of Glaciers By Henry Fountain, February 15, 2010, New York Times. Greenland's glaciers melt faster than they used to, contributing to the rise of sea levels worldwide. While warmer atmospheric temperatures thin all the glaciers from above, scientists have wondered if warmer waters are also [melting] the many glaciers that flow into the fjords. Two studies published in Nature Geoscience provide evidence that this is the case.

### Table 4. Sample comments on the videos that politicize the science.

(Continued)

Video no. / title	Science keyword I	Science keyword 2	Sample comment
7 Blue Man Group	Scientist	Evidence	A new peer reviewed analysis: Worldwide temperature increase has not produced acceleration of global sealevel over the past 100 years. The paper is currently in press at the Journal of Coastal Research and is provided with open access to the full publication. The results are stunning for their contradiction to AGW theories which suggest global warming would accelerate sealevel rise during the last century. Wake up, naive alarmists, you are being lied to.
8 Global warming scam!	Science	Scientist	The solar constant also drifts by 0.2 percent to 0.6 percent over many centuries according to scientists who study tree rings. For example, between 1645 and 1715, a period astronomers call the Maunder Minimum, the sunspot cycle stopped - the face of the Sun was nearly blank for 70 years. At the same time, Europe was hit by an extraordinary cold spell, the Thames River in London froze, glaciers advanced in the Alps, and northern sea ice increased. NASA Science news. The inconstant sun.
9 Suing Al Gore	Science	Scientist	Email 4092 from 1998 shows that University of East Anglia has a strategic alliance with Goldman Sachs. This is proof of UEA scientists' conflict of interest and a fixed agenda to drive the AGW narrative to enable carbon trading and renewable energy markets. Science is about being impartial and investigating the facts, not green activism to push a narrative that bankers want.
10 Kiribati	Science	Scientist	New World Order wants you to believe this crap, so the Rothchilds and Rockerfellers can tax you, take away your nation's sovereignty, and own everything that once was owned by nations and their people. In the name of this nutty, fanatical, fraudulent, voodoo religion, your food supply will be put at risk and your children will be plunged into poverty. Everyone knows if you pay for the scientists and the research, you get the results you want. Fraud science motivated by money and criminal deception.

### Table 4. (Continued)

change was simply wrong; and there were attempts to update the science – on both sides of the issue – by directing other YouTube users to newspaper, magazine, and academic journal articles elsewhere. In addition, although these comments concerned specific videos, most comments were in fact unrelated to their corresponding videos' content. Our mixed-methods analysis revealed that there were virtually no references to any of the specific facts presented in the video, and comments were structured to generate online discourse among YouTube users. Therefore, in terms of science-related comments, the post-video comment forum functioned as a vehicle for discussing climate change in general and not for specifically addressing the video to which they were attached.

With regard to the issue of variances in video narratives, specifically in terms of whether videos that challenged the science of climate change generated supporting comments or counterarguments by the scientific (or science-referencing) community, there was no monopoly of who discussed politicized science. Both the supporters of the claims for anthropogenic climate change as well as the skeptics tapped into arguments alleging some abuse of power. In addition, the framing of the video based on Nisbet's (2009) meta-analysis of science narratives had little bearing on the apolitical science focus of post-video discussions.

### Discussion

Given the increasing popularity of YouTube and other video-sharing websites, the question of how socio-scientific issues are framed and discussed in these new media channels has become more important than ever. In this regard, this study examines the role of the YouTube-engaged public in generating discussions on the science (politicized or otherwise) of climate change by employing both semantic network analysis and traditional discourse analysis to determine how information asymmetry is treated by the public. That is, under what circumstances do YouTube videos on climate change/global warming generate discussions that emphasize the politicization of science and scientists? Assuming (as we do) that YouTube is a representative sample of climate change discourse in the public sphere, our results provide clear evidence that people are likely to respond to claims about the science of climate change in ways that politicize (or reference the politicization of) the issue. Indeed, people politicize the issue even when the frame (i.e. the corresponding YouTube video) is disconnected from both the science and the politics of climate change. We conclude, thus, that the specific content of the video matters little in terms of the general discussion thread. Comments had virtually no connection to the facts of the video and, as a result, Nisbet's (2009) frames had little effect on the ensuing discussion. We deduce that YouTube users target videos by theme rather than by specific content when engaging the rest of the public who are either also posting in post-video discussions or simply reading the comments as a supplemental source of information.

Noteworthy is our identified distinction in the CONCOR analysis between 'science' and 'scientist'. This is particularly relevant in this study of (potentially) politicized science. Consider, for example, the case of the Reagan-era Strategic Defense Initiative. This proposed policy illustrated the potential for scientists to become politically active ('active' in the sense that they become organized to convey interests to policymakers, other elected officials, apolitical scientists, and the general public).<sup>15</sup> For climate change, scientists may be more subdued,<sup>16</sup> but events highlighted by the media (e.g. Climategate) may foster the idea that scientists are actively manipulating data by using unscientific methods. In this regard, this study explores the possibility of discussions by YouTube users also distinguishing between the science of climate change and scientists engaging in related research. Future research on politicized science should incorporate and lay heavy emphasis on this science–scientist distinction because it raises the question of whether it is the individual ('scientist') or the method ('science') that is being politicized.

Methodologically, future research should address the limitations of this study with respect to internal and external validity. We do not know, for example, whether our observations about comments are unique to the topic of climate change or are rather a function of the YouTube platform in general. Here advances in computer training techniques can be incorporated. For example, Xie et al. (2011) automatically 'tagged' YouTube videos and classified them according to the meme. Determining science narratives in a similar manner should enable 10- or even 100-fold increases in the sample size of videos. In terms of external validity, future research should address the obvious sampling bias in this study by expanding the sample. In addition, efforts should be made to integrate, for each commenter, demographic, ideology, trust, and science education measures to control for variances across commenters as it is expected that the effects we observe above are likely to differ across diverse groups of discussants (Brewer & Ley, 2013; Dudo et al., 2010). Finally, a longitudinal analysis of comments should allow for an examination of changes in discussions over time and the determination of whether there are key individuals who travel through the comment forum to catalyze discussions reflecting politicized science (Nam et al., 2013). In the absence of gatekeepers on YouTube, the relative influence of these individuals should be unparalleled.

Nonetheless, the public's recognition of a problem is the first step in creating a policy to address it. Here, this process is particularly affected by the media (Endo, 2013; McCombs & Shaw, 1972), but it also occurs through a combination of individual and institutional support, the likelihood of the problem being validated by the public and policymakers, and the use of symbols and other tools to propagate some understanding of the problem (Kingdon, 2010; Stone, 2001). For YouTube videos, the implication is that they foster activism around climate change (Porter & Hellsten, 2014). This is already well documented in general terms (Earl & Kimport, 2011), but must be drawn out for the Internet's most popular social-media platforms as activism is the most likely mechanism to explain the behavior we identify above. In this regard, future research should look beyond simply expanding the sample size to assuage concerns about external validity and go on to examine interpersonal dynamics and the potential for discussions – essentially debates – to take place. After all, the identification of a social problem and the activism which might follow are a function of effective argumentation.

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#### Notes

- YouTube does enforce a number of violations. See http://www.youtube.com/t/community\_ guidelines for complete details.
- 2. Surely the source matters as much or more than the medium.
- Nascent attempts by traditional media to incorporate viewership/readership and facilitate a nonlinear information transfer by posting Internet links or microblog hashtags have been

costly and perhaps have taken the form of elongated Q&A sessions.

- 4. Appendix 1 lists the Web address of each video under 'Web addresses of selected YouTube videos').
- 5. The 70-percent-or-greater measure is consistent with established norms (Banerjee et al., 1999). Appendix 1 presents the exact structure of the questionnaire under the heading 'Narrative questionnaire'. The respondents watched videos sequentially, as shown in Table 1. After watching a video, the respondents completed the questionnaire for that video. One questionnaire sheet was provided for each video, and the entire process took approximately an hour.
- 6. The FullText program generates a word frequency list and a co-occurrence matrix from a set of passages. This program, developed by Leydesdorff (Leydesdorff & Hellsten, 2005), is downloadable free of charge for academic purposes at http://www.leydesdorff.net/software/fulltext/.
- 7. One may question the selection of the most recent set of 1000 comments posted to a video clip. But, simply speaking, this sample size was made due to YouTube's API (Application Programming Interface) policy. Despite concerns about the generalizability of this research, previous webometrics studies show that such concerns are overstated (Khan & Vong, 2014.; Thelwall et al., 2012). See Sams et al. (2011) and Thelwall (2012), respectively, for further insight into API-based social science e-research and YouTube techniques.
- 8. The comment-based terms have all been presented in capital letters in Table 3 in order to normalize the terms across all YouTube users by removing any variance in user presentation. Because capital letters take up a lot of typographic space, we have used small caps here; and some words are given in a reduced-size typeface so as to keep them within a single table cell.
- 9. In fact, An Inconvenient Truth was specifically referenced in the video Suing Al Gore.
- 10. See Muller (2004) for a statement of these concerns.
- 11. Using only the top 50 most frequently used words enabled a clearer visual analysis of the semantic network and cluster structures.
- 12. Chung and Park (2010) used both KrKwic (a modified version of FullText for Korean text) and CONCOR techniques to compare the ideological positions of two Korean presidents. Using the presidents' inaugural addresses, they demonstrated the effectiveness of both methods. A similar approach was employed in Lee and Park (2013) and Hsu, Park and Park (2013), and Danowski and Park (2014). CONCOR techniques were conducted using UCINET (Borgatti et al., 2002), which is a commonly used software for social network analysis. For network diagrams, NetDraw packaged with UCINET was utilized.
- 13. Similar figures were generated for each of the other nine videos and are available in the Appendix.
- 14. The sample comment presented in Table 4 for the video, *Chart*, is the same as for B1 above.
- 15. See Slayton (2007) for details.
- 16. This is, of course, debatable because of the active involvement of the Union for Concerned Scientists and the American Association for the Advancement of Science in order to deal with problems conveying the science of climate change to policymakers.

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## Appendix I

### List 1. Web addresses of the selected YouTube videos

- 1. Chart: http://www.youtube.com/watch?v=zORv8wwiadQ
- 2. Lord Monckton: http://www.youtube.com/watch?v=PMe5dOgbu40
- 3. Human art: http://www.youtube.com/watch?v=0RVp8Q6H9e0
- 4. National Geographic: http://www.youtube.com/watch?v=oJAbATJCugs
- 5. Will Ferrell: http://www.youtube.com/watch?v=jOjfxEejS2Y
- 6. Polar bear animation: http://www.youtube.com/watch?v=EDIP71Lviys
- 7. Blue Man Group: http://www.youtube.com/watch?v=snPdEl0Duoo
- 8. Global warming scaml: http://www.youtube.com/watch?v=oRSOkHU2ZcQ
- 9. Suing Al Gore: http://www.youtube.com/watch?v=FfHW7KR33IQ
- 10. Kiribati: http://www.youtube.com/watch?v=cIG7vt1ZPKE

## List 2. Narrative questionnaire

Video [#]: After watching the video, *circle* the appropriate answer.

In this video, is climate change/global warming described as something ...

- ... that will be economically costly? Yes No
- ... that is a shared moral challenge for everyone? Yes No
- ... that is a solvable challenge? Yes No
- ... whose consequences we won't be able to avoid? Yes No
- ... that is a matter for scientists and experts? Yes No
- ... that is still debated by scientists? Yes No
- ... that has been blown out of proportion by scientists? Yes No
- ... that has been blown out of proportion by politicians? Yes No
- ... that reveals problems with science and expertise in policy making? Yes No
- ... that is a game among elites? Yes No

# Appendix 2. CONCOR-generated Clusters for Videos 2-10





Video 3. Human art.



























