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Mapping the climate sceptical blogosphere

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Abstract

While mainstream scientific knowledge production has been extensively examined in the academic literature, comparatively little is known about alternative networks of scientific knowledge production. Online sources such as blogs are an especially under-investigated site of knowledge contestation. Using degree centrality and node betweenness tests from social network analysis, and thematic content analysis of individual posts, this research identifies and critically examines the climate sceptical blogosphere and investigates whether a focus on particular themes contributes to the positioning of the most central blogs. A network of 171 individual blogs is identified, with three blogs in particular found to be the most central: *Climate Audit*, *JoNova* and *Watts Up With That*. These blogs predominantly focus on the scientific element of the climate debate, providing either a direct scientifically-based challenge to mainstream climate science, or a critique of the conduct of the climate science system. This overt scientific framing, as opposed to explicitly highlighting differences in values, politics, or ideological worldview, appears to be an important contributory factor in the positioning of the most central blogs. It is suggested that these central blogs are key protagonists in a process of attempted expert knowledge de-legitimation and contestation, acting not only as translators between scientific research and lay audiences, but, in their reinterpretation of existing climate science knowledge claims, are acting themselves as alternative public sites of expertise for a climate sceptical audience.

KEYWORDS: climate scepticism, knowledge, network, blog, social network analysis

1. Introduction

Outside the paradigm of mainstream climate science, and particularly in online environments, the validity of an accepted body of research underlying the scientific case for anthropogenic climate change (defined here as agreement with Section 2 (Causes of change) of the IPCC Fourth Assessment Report: Climate Change 2007) is actively disputed (Corner et al., 2012; Hobson and Niemeyer, 2012; Jacques et al., 2008; Poortinga et al., 2011; Washington and Cook, 2011). Arguments that may be considered as “climate sceptical” include, *inter alia*, that climate science is factually incorrect in terms of its scientific basis, a conspiracy among scientists to maintain or increase funding opportunities, or a politically-based rationale to increase regulation or taxes (Oreskes and Conway, 2010). This debate about climate science, as well as controversy regarding mitigation or adaptation policies, provides fertile ground for blogs. While most previous research has focused on the expression of climate scepticism in traditional media outlets (Antilla, 2005; Hoffman, 2011b; Painter and Ashe, 2012), this research contributes towards the small but growing body of literature addressing the role of virtual spaces in climate sceptical knowledge production (Cormick, 2011; Gavin and Marshall, 2011; Koteyko et al., 2012). It maps the climate sceptical blogosphere and uses social network analysis (SNA) to identify those blogs which are the most central within the overall blog network. It also uses thematic analysis to understand why those blogs identified as the most central occupy such positions of importance.

Over a decade ago, Rogers and Marres (2000) mapped the online climate change debate issue network, focusing on websites with URLs ending with .org or .gov. However, this analysis excluded the then nascent field of blogs (internet pages comprising a series of entries or chunks of information known as posts, most often arranged in reverse chronological order, either authored by a single author known as a “blogger” or by multiple contributors (Bar-Ilan, 2005)). In 2000 there were fewer than 30,000 blogs in the USA, but by 2005 this had increased to over 5.3 million (Hsu and Lin, 2008) and by 2011, there were an estimated 181 million blogs globally (NM Incite, 2012) (please note that due to the lack of a single time-series record of global blog numbers, these statistics are not directly comparable). Technorati, a blog search engine and directory, estimates there to be approximately 16,300 science blogs worldwide (Technorati, 2013); however how these blogs are categorised as such is unknown. Furthermore, there appears to be no publicly available count of the total number of blogs addressing climate change (regardless of perspective). As a result, little is known about the climate sceptical blogosphere. The blogosphere—a ‘densely interconnected conversation’ (Herring et al., 2005, p.1)—is the network of blogs and their linkages to one another, such as through hyperlinks, references to other blogs or bloggers within posts, or by commenting on others’ blogs. Climate sceptics are perceived to be ‘very present online and particularly in the blogosphere’ (Schäfer, 2012, p. 529) yet this perception has yet to be adequately addressed with empirical research. Understanding blogs as sites of knowledge formation and contestation is critical because, as Hsu and Lin (2008, p. 65) note, blogs can ‘attract tremendous attention and exert great influence on society’, resonating with different groups according to their content, format and authorship (Bar-Ilan, 2005). Furthermore, while blogs may have low overall visitor numbers as compared to

traditional media outlets such as television news or radio broadcasts, their relatively high readership by so-called 'elite' actors such as journalists enables a much higher penetration of blog-generated or transmitted ideas to the general public than may otherwise be expected (Farrell and Drezner, 2008). For example, in a study of 300 journalists, Dautrich and Barnes (2005a, b) find that 83% reported having used blogs (with 41% reporting using them at least once per week) as compared to only 7% of the general population.

Focusing on the blogosphere as a network also enables key sites of influence to be identified and to understand whether information or viewpoints are widely generated and dispersed, or shaped by a smaller number of attitudinal influencers. As blogs become an increasingly important contributor to public discourse (Carlson, 2007) and inspire reflection on the use of knowledge in decision-making (Ravetz, 2012), identifying the main sites of sceptical opinion formation and the arguments employed is also valuable to those engaged in science communication or climate policy decision-making. Finally, this paper aims to make a wider contribution to the literature on alternative knowledge networks by highlighting the potentially significant role of central blogs as knowledge gatekeepers, and also how attempts are made to disrupt traditional understandings of how knowledge is both formed and accepted as legitimate.

2. Knowledge, networks and contestation

Traditional frameworks of scientific knowledge production limited its creation to official spaces such as universities, and as the domain of those who were formally qualified as arbiters of knowledge by virtue of their academic credentials (Martin and Richards, 1995). These actors, closely networked within small epistemic communities of practice, were perceived as creating scientific knowledge that was 'objective and context-free' (Wynne, 1992, p. 282), with a clear distinction between the legitimacy of the knowledge created by the scientist and the 'man-in-the-street' [*sic*] (Merton, 1973, p. 277). Insights from the sociology of scientific knowledge have challenged these frameworks, with theories such as Mode-2 knowledge production or post-normal science explaining that knowledge is created across multiple sites and by multiple actors (Funtowicz and Ravetz, 1993; Gibbons et al., 1994; Nowotny et al., 2003). Crompton (2007) explains that these new knowledge networks involve the public speaking back to science, creating new public arenas ("agoras") where scientific information is contested to make it more socially robust. The climate sceptical blogosphere, as a site of active knowledge contestation, could therefore be understood as a (virtual) site of Mode-2 knowledge production. Indeed, Donald (2011) suggests that, by understanding climate science as post-normal, networks of contrarian bloggers may also be understood as new types of global advocacy networks. However, it is unclear whether the blogosphere is a "functioning" agora as Crompton suggests is the case in her description of the orphan drug network. The mutual learning necessary for a functioning agora where the 'public [is] accepted as a legitimate partner exerting democratic rights of participation' (Crompton, 2007, p. 201) appears to be less apparent overall in the case of climate change, with Hoffman (2011b, p. 9) identifying a 'logic schism' between different actors in the debate, across which dialogue is extremely

difficult. Climate scepticism, as a challenge to mainstream climate science and policy, does not reflect 'an absence of certainty, but rather of *contradictory certainties*: several divergent and mutually irreconcilable sets of convictions both about the difficulties we face and the available solutions' (Hannigan, 2006, p. 29, emphasis in the original). As well as policy choices, scientific evidence itself is actively disputed, with, for example, knowledge claims presented within the climate debate as either "sound" or "junk" science (McCright and Dunlap, 2003). Sound science emerged as a term during the early 2000s bovine spongiform encephalopathy health scare in the USA when scientific—instead of economic—rationales were employed to defend policy responses. Evidence that does not fit the desired policy frame is conversely labelled as "junk science", although critics using the sound science argument often refer to incomplete data and scenario modelling (two things inherent to climate science) as key elements of junk science, rather than engaging in a direct debate about the quality of the extant data itself. As McGarity (2003-2004, p. 901) argues, 'stripped of their rhetorical flourish, "junk science" means "their science" and "sound science" means "our science"'.

In contrast to controversies such as the health impacts of tobacco smoking which is no longer widely publicly disputed, the more scientifically abstract nature of climate science and its inherently values-laden character means that scientific evidence alone is inadequate to drive policy decision-making (Hulme, 2009). Hoffman (2011a) argues that the climate debate may have entered into the realm of what Pielke Jr. (2007) coins "abortion politics", that is, a situation where no amount of scientific information can reconcile the different values held on a certain topic. This is in contrast to the "rational-instrument" approach whereby science is seen as providing 'verifiable facts about reality on which rational policy decisions can be based' (Gulbrandsen, 2008, p. 100) and which would suggest that climate change could be resolved by systematically uncovering factual knowledge. It is important to recognise that the range of potential policy responses to climate change each hold deeply embedded ideological implications, with Hoffman (2011a, p. 3) providing the example of attendees at a climate sceptics' conference in 2010 stating that 'the issue isn't the issue'; instead, that 'climate change is just another attempt to diminish our freedom'.

While the academic literature to date has mainly focused on the manifestation of climate scepticism in the mainstream media (Boykoff, 2007; Schmidt et al., 2013), little work has been done to understand why climate sceptical blogs exist and what their role may be as public sites of knowledge contestation. Several elements are relevant to consider, including conflict over the legitimacy of the public's ability to contribute valid climate change knowledge, particularly where it disputes mainstream climate science (Douglas, 2009), mistrust by some regarding the data and methods used to create climate predictions (exemplified by the "Climategate" controversy, where more than 1000 emails and documents were stolen or leaked from the University of East Anglia in 2009), or a desire for greater transparency overall in the scientific process (Nerlich, 2010). The notion of knowledge networks under Mode-2 conditions provides a particularly useful analytical framework, as the production of knowledge and specifically, its *reproduction* by different actors in

a network helps to identify which types of information are most relevant to a particular debate, as well as showing how framing and sources contribute to knowledge legitimacy. For example, Kahan et al. (2011) suggest that even the perception of whether a scientific consensus *exists* on a certain topic is determined by both the source of the information in question, and the side upon which consensus forms. This flow of knowledge enables the creation of what Cope and Kalantzis (2009, p. 5) term 'dispersed communities of expertise', with the format of online networks in particular promoting near instant feedback on knowledge claims (Koteyko et al., 2012).

Furthermore, while the ways in which mainstream science and policy is organised and interact have been the subject of considerable attention (Berryman, 2006; Daviter, 2007; McCright and Dunlap, 2003; Zuckerman and Merton, 1971), correspondingly little is known about contemporary online sites of knowledge contestation and how this knowledge is created and disseminated across virtual space. These new sites of knowledge (re)production that blogs embody are important to address because they facilitate 'a shift in the balance of textual agency between the author and reader' (Cope and Kalantzis, 2009, p. 6) by enabling contested knowledge to be freely circulated, and to act as direct challengers to "official" expertise. While it is possible that these climate sceptical blogs are not making a significant impact on public discourse outside the online environment, this seems unlikely, as blogs are increasingly recognised as important contributors to the public climate change debate (Guimaraes, 2012). Blogs' low entry barriers compared to peer-reviewed journals, which are generally too expensive to access for non-institutional readers (Harnad, 1998) or written in an overly obtuse or technical style (Culler and Lamb, 2003; Eagle et al., 2012), may also give them a unique position as a mediator of public discourse.

3. A networked blogosphere

As a tool to express opinions and disseminate ideas, blogs are an increasingly popular online phenomenon (Wei Lai, 2009), particularly given the rise of free blogging platforms which require little technological know-how (Hookway, 2008). Blogospheres, as networked user communities, contribute to the creation of attitudes and transfer of information and ideas (Bruns et al., 2011; Etling et al., 2010; Moe, 2011; Tremayne, 2007; Tremayne et al., 2006). However, while individual blogs have been recognised as significant disseminators of knowledge, particularly knowledge which may be deemed partisan (Lowrey, 2006), comparatively little work has been undertaken that examines these sites of knowledge contestation as a networked whole.

Social network analysis (SNA) is a useful method to examine blogospheres as it provides a coherent mechanism to interrogate their structure. For example, the use of links between blogs enables the connectedness of the blogosphere to be explicitly mapped (see Herring et al., 2005 for a more detailed discussion of the merits of SNA in analysing blogospheres). A social network may be thought of as a

'collection of social actors and their interconnections... [which] consists of nodes (social actors) and links between the nodes (the interconnections)' (Sun and Qiu, 2008, p. 1769). SNA is used to analyse these links, emphasising the interconnections between actors rather than the characteristics of the actors themselves (Borgatti et al., 2009). Centrality is a core concept within SNA, with a variety of approaches (such as degree, closeness or betweenness) used to measure 'the locations of individuals in terms of how close they are to the "center" of the action in a network' (Hanneman and Riddle, 2005, p. 147). Those nodes in particularly central positions are also understood in SNA as potentially powerful, with power in this context existing as a result of the advantageous position of a node in comparison to others. While the 'question of how structural position [i.e. centrality] confers power remains a topic of active research and considerable debate' (Hanneman and Riddle, 2005, p. 168), this research will follow the lead of Brass (1984, p. 520) who argues that, 'actors or units occupying central positions in a network are viewed as potentially powerful because of their greater access to and possible control over relevant resources'. This focus on centrality is particularly relevant to the study of a blogosphere, as it enables a focus on those blogs most likely to play a role as pivotal sites of opinion formation and reinforcement.

In addition to centrality, clustering is also argued to be an important characteristic of a blogosphere (Barabási et al., 2000; Newman et al., 2002; Watts, 1999) whereby relationships are indicated by bloggers linking to or commenting on others' blogs, or via the existence of "blog-rolls" which are links to other blogs displayed on either the home-page or links page of a blog (Adamic and Glance, 2005). Bruns et al. explain the importance of blog-roll links:

Patterns of interlinkage between contemporaneous blog-rolls indicate the existence of a long-term network of recognition between peers. Sites with many incoming and outgoing links may be understood as hubs for communication in this network; sites with many incoming, but limited outgoing links may be understood as central sources for information; sites with many outgoing but few incoming links may be understood as (not necessarily central) distributors of attention to other members of the network (2008, p. 3, emphasis in the original).

Blog-rolls indicate long-term connectivity between bloggers, as opposed to a link found within a single post, and can also be understood as an indicator of ideological closeness or shared interest (Caiani and Wagemann, 2009). The number of incoming versus outgoing linkages is interesting, as those blogs with 'a high number of incoming links... can be understood as the most respected blogs in the overall population' (Bruns et al., 2008, p. 6), whereas those blogs with many incoming *and* outgoing links are important hubs within the network, playing a role as connector nodes, and thus contributing to a tight-knit cluster formation (Sun and Qiu, 2008). Rogers (2012) argues that these incoming links may serve as an indicator of reputation and, what he terms as

the “politics of association”. That is, blogs will only link to others with whom they want to be associated in an effort to create a coherent group (Niederer, 2013).

Also of relevance is the user community's perception of the credibility of the information contained and shared within the blogosphere. This is particularly important to climate sceptical blogs providing an alternative explanation to mainstream climate science (as opposed to blogs focusing on, for example, climate change policy choices). In a survey of over 3,700 readers of more than 60 blogs of diverse content, Johnson and Kaye (2004) found that nearly three-quarters considered blogs “moderately” to “very” credible sources of information, with their particular strength being the provision of in-depth information. Readers did however acknowledge that the accuracy and neutrality of blogs may be questionable, with half the respondents judging blogs as either “somewhat” or “not very” accurate or fair (this is a significantly lower assessment of credibility than that perceived of Wikipedia entries, as found by Chesney, 2006). Yet Johnson and Kaye argue that this does not appear to be inherently problematic as blog readers tend to seek out information to support their own views (Kahan et al., 2011), and as Hsu and Lin (2008) propose, bloggers themselves are blogging because they want to share their own opinions and influence others by the knowledge they provide.

4. Method

A multi-stage process was followed in order to a) map the climate sceptical blogosphere, b) identify the most central blogs, and c) understand why the most central blogs occupy such positions of importance. This section explains the blogosphere mapping process, with Section 5 discussing the SNA tests and Section 6 outlining the thematic content analysis.

To identify the population of climate sceptical blogs, the search string “climate blog” was entered into *WebCrawler*, with the initial 12 pages of results used as the basis from which all further blogs were identified via a snowball method using blog-roll links. *WebCrawler* is an integrated online metasearch engine combining Google Search and Yahoo! Search results. At the time of research, it also included Microsoft's Bing Search. A metasearch engine was chosen in order to obtain the most comprehensive search results possible, as it combines the results from multiple search engines into a single output (Lawrence and Giles, 1999). Inclusion and exclusion criteria were implemented in order to create a coherent dataset, with all blogs identified and assessed manually to ensure only relevant blogs were identified (Heath et al., 2009). First, the blog had to identify itself as a blog about climate change, either through use of the term “climate” or “global warming” in the title, or through substantive discussion in posts. Substantive was determined as at least 50% or more of the blog's content and was assessed in two ways. If tags were allocated to a post, a frequency analysis was undertaken and if 50% or more of the posts were tagged as “climate change” or similar, it was added to the network. Where tags were not present or were ambiguous, the first five pages of each blog were

analysed using content analysis to determine whether 50% or more of the posts could be categorised as climate change-related. While this coding process is inherently subjective, it did not limit the rigour of the analysis as this process of 'recognizing (seeing) an important moment and encoding it (seeing it as something) prior to a process of interpretation' (Fereday and Muir-Cochrane, 2006, p.83) was based on an extensive grounding in the climate change literature. 37 blogs were excluded for not having climate change as majority content, including political blogs such as the *Australian TEA Party* or weather blogs such as the UK's *Met Office News Blog*.

Second, the blog had to be identified as climate *sceptical*. This was determined by individual assessment of each blog's content insofar as it employed language which agreed with Rahmstorf's (2005) typology of trend, attribution or impact climate scepticism. As Painter (2011, p. 54) explains, trend sceptics are 'those who say global temperatures are not warming', while attribution sceptics are 'those who say they [global temperatures] are warming, but argue that the anthropogenic contribution to global warming or climate change is overstated, negligible, or non-existent compared to other factors like natural variations or sun spots' and impact sceptics are 'those who accept it is happening but for different reasons question its impacts or the need to do something about it'. While this was clearly evident in most cases, a categorisation system became a necessary addition in order to distinguish between types of blogs, as there was a marked difference in language employed. Two categories were developed: openly sceptical (category 1) and self-proclaimed "open-minded" (category 2). For example, compare the following excerpts in Table 1 from *Climate etc.*, a category 2 blog authored by Judith Curry (Georgia Institute of Technology) and *GORE LIED*, a category 1 blog authored under the pseudonym "The Editor", based in Oregon, USA. In the *GORE LIED* excerpts, the phrase 'the foundation for anthropogenic global warming is fraudulent' and the suggestion of climate scientists and policy-makers personally profiting from the existence of climate change clearly identifies it as a category 1 blog. Conversely, in the *Climate etc.* excerpt, the discussion of the need for greater causal investigation into the scientific factors behind the physical manifestation of climate change is markedly different in tone, hence its classification as a category 2 blog.

[TABLE 1 HERE]

Third, the blog had to present new content, thus excluding three blogs that collated posts originally published elsewhere such as *Climate Depot*. Fourth, it had to present itself in a blog format, requiring elements typical to a blog such as post headings, dates, tags, and contributing author identification (Bar-Ilan, 2005). This excluded 57 websites. Fifth and finally, four blogs were excluded because they were not written predominantly in English. This is a recognised limitation of this research, as the presence of non-English language blogs in the identified network, and an unknown number of non-English language blogs that were not identified via blog-roll links, constitute a missing space of unknown size. However, this research is predominantly interested in English language blogs, building on previous research in the communication of

climate scepticism which emphasises the Anglo-American or Anglo-Saxon nature of the phenomenon (Niederer, 2013; Painter, 2011). Six blogs were retired or appeared inactive, yet were included in the network as potential sources of static information. A blog containing pornographic images as well as climate sceptical posts was excluded, despite being linked to by several other blogs. Three parody blogs which purported to be climate sceptical, but on closer investigation were actually satirical in nature, were also excluded from the dataset such as *The Climate Scum*.

To carry out the SNA, a one-mode network adjacency matrix was created based on blog-roll linkages and analysed using the computer programme UCINET and its accompanying graphical visualisation software, NetDraw. As Borgatti et al. (1999p. 15, emphasis in the original) explain, 'the rows and columns of the adjacency matrix [in UCINET] correspond to the nodes of the graph [in NetDraw], and the cells in the matrix correspond to pairs of nodes or *dyads*. A matrix value $X(i,j) = 1$ indicates the presence of a link between node i and node j , and $X(i,j) = 0$ indicates the absence of a link'. In this case, the matrix value of 1 indicated the existence of a blog-roll link. The inclusion and exclusion criteria were particularly important to the adjacency matrix, as to list all the blogs included on the identified blog-rolls without focusing on a particular topic would have resulted in a likely ever-expanding network of blogs. Some of the blog rolls differentiated their blog-roll links into groupings (such as "climate" or "politics") as well as identifying fellow sceptical blogs and those on the "other side" of the debate. *The Global Warming Heretic* provides a good example of this, with its blog roll divided into the following sections:

- Data (5 links)
- Fellow heretics (87 links)
- Mostly impartial (1 link)
- GW/CC [global warming/climate change] news (16 links)
- True believers, Hangers-on, Folks who don't know any better, and folks who should know better (54 links)
- Carbon brokers (4 links)
- Heretic sympathizers (1 link)
- Other heretics (non-AGW [anthropogenic global warming]) (5 links)

The Global Warming Heretic also provides a note about its classification system, with the categories explained as follows:

I have done my best to classify the links into the stated categories based on my impression about the general thrust of each of these sites. Sites classified as 'Fellow Heretics' will not necessarily agree with me on all issues related to climate change—they merely contain content that unapologetically diverges

from the consensus. Sites classified as 'True Believers' are those that have accepted the essence of the AGW hypothesis—but some present their views reasonably rather than in the hysterical fashion of the CoGW [Church of Global Warming].

In such cases, only those blogs identified as sceptical by the blogger themselves were added to the adjacency matrix. Both the adjacency and attribute matrices were analysed using UCINET and NetDraw, with the results explained in the following section.

5. Results

In total, 171 blogs were identified, 155 of which are allocated to category 1 (openly sceptical) with the remaining 15 identified as category 2 (self-proclaimed “open-minded”). Note however that this is a snapshot of the blogosphere created during March-April 2012. It is expected that many blogs will no longer exist by the date of publication and concomitantly, that many others will have been created. Of those blogs whose authorship could be determined (155 blogs, with authorship identified via the blogger naming their location), nearly half (75) are authored from within the USA. Where both author location and nationality were identified but were different, author location was chosen. In descending order of prevalence, the authorship of the remaining blogs is: Australia (32), United Kingdom (26), Canada (9), New Zealand (5), and the Czech Republic, Denmark, Germany, India, Ireland, Israel, Italy and Sweden (1 each). It is interesting that seven of the blogs whose authorship could be determined come from predominantly non-English speaking countries, yet are written in English. This may be due to these bloggers' desire to connect with the predominantly Anglo-American/Saxon manifestation of climate scepticism as referred to above (Niederer, 2013; Painter, 2011).

Of the 171 blogs, 114 list links in a blog-roll. Only one blog (found via the initial scoping process using *WebCrawler*) is not linked to the remainder of the network. The geodesic distance of the entire network is measured at 2.71, that is, only 2.71 blogs on average separate each blog from another. While this may seem like a densely connected network, employing UCINET's density algorithm shows a density rating of only 0.06. The density of the network examines the proportion of possible ties that are present, with a density rating of 1 meaning that every blog would be directly connected. Thus, of all possible ties, only 6% are present, suggesting a low-density network. Figure 1, which visualises the blogosphere using an ego network display, clearly indicates that other clusters of relationships, for example through particularly central nodes, may instead be important to investigate. Using the arc method, the reciprocity of the network (how many blogs link to each other) was analysed to assess the blogosphere's interdependency, with a result of 19.93%. This result, where less than a quarter of blogs provide reciprocal links on their respective blog rolls, in addition to the low network density, appears to provide further evidence for a blogosphere that depends on central nodes. Three centrality tests were selected to achieve the goal of determining the most central nodes

within the blogosphere. Those blogs that appeared in the top 10 of each reciprocal centrality test (for example, both in- and out-degree ratings) were placed on a short-list of central blogs for subsequent analysis. Table 2 outlines these tests and the short-listed blogs.

Figure 1: The climate sceptical blogosphere, where round nodes are category 1 (openly sceptical) and square nodes are category 2 (self-proclaimed "open-minded")

[FIGURE 1 HERE]

[TABLE 2 HERE]

Two tests for degree centrality (Freeman's and Bonacich's approach) were chosen as 'very simple, but...very effective measure[s] of...centrality' (Hanneman and Riddle, 2005, p. 148). Freeman's approach shows the centrality of a node based on its degree, that is, the number of connections a node has. In this case, the rating score represents the number of other blogs linking to that blog on their respective blog rolls. The blog with the highest in-degree rating according to Freeman's approach is *Watts Up With That (WUWT)*, with 54% of the blogosphere linking to *WUWT*, which claims to be the 'world's most viewed site on global warming and climate change'. Freeman's approach may also be used to analyse out-degree linkages, that is, examining which blogs' blog-rolls are the most extensive. While out-degree score is usually seen as a measure of how influential an actor is in a network, in this case, a blog has no control over whether it is included in another blogs' blog-roll. It is thus possible that out-degree score in a blogosphere context may instead be regarded as an indicator of desire to enhance the network, for example, by ensuring readers are aware that there exist other blogs that support the position of the original blog. Interestingly, only two blogs show both high in- and out-degree linkages (*WUWT* and *Bishop Hill*). Tables 3 and 4 show the top 10 Freeman's approach scores for in- and out-degree linkage.

[TABLE 3 HERE]

[TABLE 4 HERE]

Bonacich's approach for degree centrality is a more nuanced mechanism to determine both centrality and power based on the number of secondary connections attributed to a node. A positive coefficient of 0.5 is used to determine centrality, that is, whether the blogs that are linked to on a blog-roll have themselves many subsequent links. Centrality is achieved because the node is linked to other nodes that are well-connected. A negative coefficient of -0.5 is used to determine power, with the concept of power understood in this test as whether a blog is connected to many blogs without further links themselves. Power is implied because a node that is connected to few other nodes is more dependent on them than if it was connected to many others (Hanneman and Riddle, 2005). The positive coefficient test to determine centrality provided some very different results to both the Freeman's approach tests, with Table 5 showing *The Friends of Carbon Dioxide*

as the most central. The blogs to which *The Friends of Carbon Dioxide* links on its blog-roll have themselves many subsequent links, indicating that it may be well-attuned to the key nodes in the climate sceptical blogosphere. The negative coefficient test to determine power assigns negative values to well-connected nodes and positive values to weakly connected nodes. In the case of a blogosphere, the results for this test may indicate that high-scoring blogs are serving as key sources of inspiration and information. According to the negative coefficient results (Table 6), *The Friends of Carbon Dioxide* is less powerful, only ranking sixth. The blogs *GORE LIED*, and *The Global Warming Heretic* scored in the top 10 results of both the positive and negative coefficient tests.

[TABLE 5 HERE]

[TABLE 6 HERE]

In order to test the results for degree centrality (as the number of connections may not necessarily indicate the relative importance of a node within a network), a test for betweenness was also conducted. Betweenness centrality is used to highlight those nodes upon which others depend to make connections. In traditional SNA, this is a measure of whether a node is “between” other nodes in a network, for example, how many people depend on an individual actor to make connections with other people. In the case of a blogosphere, a blog may achieve a high score if it is linked to by many other blogs (thus results for this test are expected to be similar to those for in-degree rating using Freeman's degree centrality). Table 7 shows that *WUWT* is an extremely central node according to this test. The results of this test are interpreted against the mean betweenness score. *WUWT* has a score of 3971.52, significantly higher than the mean score of 180.31. As anticipated, there was a large overlap between the results for this test and those for Freeman's in-degree centrality, with six blogs appearing in both sets of results. *Climate Audit*, *ICECAP*, *JoNova* and *No Frakking Consensus* were short-listed based on these results.

[TABLE 7 HERE]

6. Analysis

The centrality test results show that nine blogs from the total network of 171 could be considered to be the most central nodes within the climate sceptical blogosphere: *WUWT*, *Bishop Hill*, *Climate Audit*, *GORE LIED*, *ICECAP*, *JoNova*, *No Frakking Consensus*, *The Friends of Carbon Dioxide* and *The Global Warming Heretic*. However, while a blog may appear to be influential as a result of high centrality scores, this position may be illusory, created through mathematical analysis rather than actual influence. Delving deeper is a vital part of good SNA, as the results should not be viewed in isolation, or necessarily meaning that the ‘measured relationships and relationship strengths as accurately reflecting the “real” or “final” or “equilibrium” status of

the network' (Hanneman and Riddle, 2005, p. 13) in question. In nearly all respects, apart from all having blog-rolls, they are heterogeneous. *Climate Audit* is a category 2 blog, whereas the remainder are category 1. Four are USA-authored, three in Australia, and one each in Canada and the UK. *WUWT* and *JoNova* receive hundreds of comments per post, whereas *The Friends of Carbon Dioxide* regularly receives either none or fewer than five comments per post. *GORE LIED* and *The Global Warming Heretic* appear to both be infrequently updated (or retired) which is an important discount factor in the blogosphere, where quick turnaround of information is critical to retain readers' attention and get repeat visits. In order to test the SNA results, reader statistics were employed to indicate the blogs' relative importance to the blogosphere user community (however, it is also important to note that site traffic should not be interpreted as an indicator of credibility *per se*—while site traffic may provide an indication of relative attention, these results only demonstrate site traffic as compared to each other (and not to wider traffic to other websites or blogs) and can in no way indicate how the information contained within each blog is regarded or interpreted). Google's *Ad Planner* was used to estimate site traffic. Very little research is available that compares the accuracy of publicly-accessible (both free and subscription) site-traffic estimation services (Vaughan and Yang, 2013). In the absence of such research, *Ad Planner* was chosen as it yielded the most data on the short-listed blogs as compared to other services. Moreover, it does not provide information for low-traffic websites, thus suggesting that if any of the nine blogs were not tracked, they are unlikely to receive significant traffic. As shown in Table 8, only four of the nine blogs appeared in the *Ad Planner* results: *Climate Audit*, *ICECAP*, *JoNova* and *WUWT*. *ICECAP* receives significantly fewer estimated page views per month than the other blogs and was thus excluded from the final analysis.

[TABLE 8 HERE]

In order to understand why *Climate Audit*, *JoNova* and *WUWT* occupy the most central positions in the climate sceptical blogosphere according to the SNA and site traffic results, thematic content analysis of multiple posts from each blog was performed. Thematic content analysis was chosen as it enables an assessment and subsequent classification of each individual post, focusing in particular on the key thematic preoccupations of the blogger (i.e. what is the content deemed most important to therefore post online), and on how the information is presented and interpreted (i.e. what terminology or language is used in the post/how is the argument framed) (Fereday and Muir-Cochrane, 2006). 20 posts in chronological order dating from 1 March 2012 were identified from each blog, with each post categorised under either "science", or "policy". The categories of science and policy were chosen as they are the most prevalent underlying themes of climate scepticism identified in the literature in terms of climate sceptical arguments (Rahmstorf, 2005). While such categorisations have also been associated with different motivations behind climate sceptical viewpoints (Hulme, 2009; Washington and Cook, 2011), an investigation of underlying motivations was beyond the scope of this research (and again, served to direct the methodological choice towards manifest thematic

analysis as opposed to, for example, discourse analysis). "Science" included all scientifically-related points, including any argument that referenced scientific data or methods, scientific transparency, scientific theories or the role and activities of scientific institutions. No distinction was made between what has been suggested as being 'scientifically legitimate' arguments (Freudenburg and Muselli, 2010, p. 483) as opposed to 'non-science and pseudoscience' (Cormick, 2011) or the dressing of 'science denial in the trappings of science' (Rosenau, 2012, p. 567). This is an important point to emphasise, as the aim of this research is not to cast judgement on the validity or legitimacy of the blogs' content, such as the scientific knowledge claims contained within specific posts, but to understand how the choice of topic contributes to a blog's position in the network. As such, it focuses on overtly manifest themes and language, rather than analysis of any latent discourse or identification of motivated reasoning behind specific framings of climate change (Whitmarsh, 2011) (both beyond the scope of this specific piece of research). "Policy" included all discussions that emphasised the politics of, or policy decisions related to, climate change, such as the political appropriateness of mitigation or adaptation policies. While this categorisation may appear to be an overly simplistic binary (particularly given the complex interrelationships between science and policy as outlined above in relation to theories such as post-normal science), it was chosen as a way of most accurately reflecting the *overt* choice of topic made by each blogger. While research has shown that it is very likely that the motivations behind the expression of climate sceptical arguments and opinions relate to particular values, or political or ideological worldviews (Corner, 2013; Hulme, 2009; McCright and Dunlap, 2000, 2003, 2011; Poortinga et al., 2011), the *choice* of scientific language or scientific framings as the vehicle through which climate scepticism is communicated is also important to understand, as it allows for an insight into the issues deemed most pertinent, or indeed most convincing, to the debate in the blogosphere environment. It is thus important to emphasise that it is not the aim of this categorisation system to make "policy" synonymous with an ideologically-motivated scepticism, nor to suggest that "science" is conversely ideologically independent. Where neither of these categories was an accurate fit, a further category of "other" was used. More detailed sub-themes were also used, including "funding sources" or "transparency" under the overall category of science, and "regulation" or "government agency" under the overall category of policy.

The dominant category across all three blogs was science. 95% of the analysed posts on *Climate Audit* were categorised as science, with the remaining post categorised as other. 50% of the posts on *JoNova* were categorised as science, with the remaining 50% split equally between politics and other. 100% of the posts on *WUWT* were categorised as science. The overall category of science was supplemented by several sub-themes, with discussions of alternative scientific rationales for observed climate variability and extreme weather events, and critiques of techniques and results from mainstream climate science such as computer modelling of surface temperature data particularly prevalent. Distrust of scientists involved in mainstream climate science and associated scientific arguments was also a frequently occurring point of contestation, including claims that mainstream climate scientists' claims were scientifically invalid.

Climate Audit appeared to be predominantly interested in issues of scientific transparency, such as information access, funding sources and scientific integrity. For example, the following excerpt from a post entitled *Schmidt's "Conspiracy Theory"* (16 May 2012) discusses efforts that *Climate Audit* made to access primary data:

Wahl and Ammann announced in May 2005 that all our claims were "unfounded". Since our codes were very close and I reconciled them almost immediately, I knew that their verification r2 results would be identical to ours. Again, I was asked to review the paper (though my review was disregarded.) As a reviewer, I asked for the verification r2 results. Wahl and Ammann refused. Rather than rejecting the paper, Schneider terminated me as a reviewer.

JoNova discusses a broader range of topics (for example, fake gold bars and full-body scanners at airports), yet still has a clear interest in scientifically-related climate sceptical arguments. Key sub-themes included conspiracy theories (predominantly regarding climate scientists) and media behaviour when discussing climate science. For example, in a post entitled *Monbiot—Steal things and be a "democratic" hero* (4 March 2012), referring to journalist George Monbiot, *JoNova* argues that the 'richest of ironies is that Monbiot relies on models and opinions, while the skeptics that he looks down upon want observations and data, true to the original tenets of the scientific method. Despite not apparently knowing what makes science different from a religion, he calls skeptics "anti-science deniers"'. *WUWT* is extremely prolific, with 190 posts for March 2012 alone; however, the posts analysed had several reoccurring sub-themes under the overall category of science, with a predominant interest in alternative explanations for climate models, temperature data or human-induced climate change, largely in the form of scientifically-based challenges to published science. For example, the following excerpt from *Why William D. Nordhaus Is Wrong About Global Warming Skeptics Being Wrong...* (3 March 2012) disputes mainstream climate science knowledge claims: 'As the Earth's climate continues to not cooperate with their models, the so-called consensus will eventually recognize and acknowledge their fundamental error'. Across all three blogs, the two most prevalent sub-themes identified were a) direct scientifically-based challenges to mainstream climate science, and b) critiques of the conduct of the climate science system, such as individual climate scientists' actions (including issues of transparency) or institutional decision-making. While the latter sub-theme may be understood as related to more "political" understandings of science (such as the relative role of science as a factor in decision-making under controversy), as it is still overtly discussing the organisation of climate science as a whole, it was still categorised as science.

While the three most central blogs focus on scientific framings of the climate debate, it is possible that other, non-central, blogs also have a similar focus and that, instead of being a significant factor in the centrality of

these blogs in particular, it is broadly characteristic of the entire climate sceptical blogosphere. To test this, of the 162 blogs not identified as central in any way, 20 were randomly selected, with 20 posts from each blog dated in chronological order from 1 March 2012 subject to thematic content analysis and allocated to one of the three main categories: science, policy or other. Where a blog had more than 50% of its posts allocated to a single category, that category was assigned as the overall theme of the blog. Of the 20 randomly selected blogs, the majority (65%) were categorised as policy, focusing on issues such as energy policies or climate change legislation. For example, of the 20 posts analysed from *Tory Aardvark*, six focused on wind-farm policies, five examined international or UK climate politics, one discussed climate science, and the remaining eight investigated topics as varied as the psychology of climate change fear and the teaching of climate change in schools. 30% of the 20 non-central blogs focused on climate science, using similar arguments and content as was found in the most central blogs, such as discussions of the authority of climate models or IPCC predictions, with only one blog allocated to the category of other as it was solely preoccupied with the weather-related impacts of climate change.

7. Conclusion

This research aimed to identify the climate sceptical blogosphere and its most central nodes, and to investigate whether a focus on particular themes contributed to the positioning of the most central blogs. A blogosphere comprising 171 individual blogs was identified using SNA, with three blogs in particular, *Climate Audit*, *JoNova* and *WUWT*, identified as the most central based on three tests of centrality (Freeman's and Bonacich's approaches for degree centrality and Freeman's betweenness) and site-traffic. While the SNA provided varied results as to which blogs may be considered the most central, the results of one specific measure of centrality, in-degree rating according to Freeman's approach for degree centrality, appear to be particularly relevant. The three blogs identified as the most central are also the top three most linked-to sites according to Freeman's in-degree rating. This suggests that in-degree connectivity may be an important indicator when analysing the centrality of a blogosphere, although further research on different blogospheres is required to test this hypothesis. It does however accord with Bruns et al.'s (2008) contention that a blog with a high number of incoming links may be understood as highly respected by its peers.

The most noteworthy finding of this research however is that the blogs identified as the most central predominantly focus on the scientific element of the climate debate. Regardless of the motivation behind the existence of the climate sceptical opinion, what appears to be the most valued and legitimate way of expressing that opinion within the blogosphere is through the use of scientific themes and language. Within this overall focus, providing a direct scientifically-based challenge to mainstream climate science, or a critique of the conduct of the climate science system (such as individual climate scientists' actions or institutional decision-making) appear to be particularly important themes, thus according most closely with Rahmstorf's (2005) categories of trend or attribution scepticism. The central blogs' overt framing of climate sceptical

arguments within the language of contested scientific knowledge claims and critiques of science conduct is interesting for multiple reasons. First, it suggests that the blogosphere is still preoccupied with framing climate change as an active *scientific* controversy. Whilst multitude scientific uncertainties regarding climate systems still exist, fundamental components of climate science such as the relationship between anthropogenic greenhouse gas emissions and temperature increases are no longer considered contentious within the academic literature (IPCC, 2011, 2013). As newspapers such as *The Los Angeles Times* and *The Sydney Morning Herald* refrain from publishing reader letters which deny anthropogenic climate change (Lewis and McEvoy, 2013; Thornton, 2013), it is possible that scientifically-framed climate sceptical arguments may become increasingly rare in traditional mainstream media fora, instead retreating into the unregulated blogosphere environment. Second, it contradicts claims that climate science is 'adrift in the blogosphere' (Schäfer, 2012, p. 529) because even though few climate scientists themselves blog—and are suggested to mainly focus on addressing the "pseudoscience" suggested as existing within the climate sceptic blogosphere (Schäfer, 2012)—this does not mean that science itself is not an active topic of discussion. Finally, it also suggests that by *not* focusing on, or explicitly identifying, debates regarding the ideological foundation for climate change disagreement, which more explicitly highlights 'attitudes and worldviews...[and] political ideology and personal values' (Poortinga et al., 2011, p. 1022), the blogosphere may be playing a central role in perpetuating doubt regarding the scientific basis for subsequent climate change policy-making. This conclusion therefore stands somewhat in contrast to the results found by Elsasser and Dunlap (2013) whose analysis of conservative columnists' discussion of climate change shows a strong preoccupation with trend sceptical arguments, yet a concomitant emphasis on connecting the political figure of Al Gore with these arguments.

The expertise that appears to be the most valued in this alternative knowledge network—command of scientific knowledge and willingness to use it to critique mainstream climate science—is thus also different to that valued in other alternative knowledge networks. For example, in the knowledge networks formed by UK mothers in response to the potential threat from the measles, mumps and rubella vaccine, 'personalised framings' (Poltorak et al., 2005, p. 717) rather than disputes over the scientific evidence were predominant. Thus building on Merritt and Jones' (2000) suggestion of climate sceptics as "agents of persuasion", this research has shown that these central nodes are key protagonists in a process of continual *expert* knowledge de-legitimisation and contestation. Interestingly however, and in opposition to the Cumbrian sheep farmers in Brian Wynne's classic investigation of expertise, these bloggers do not appear to recognise a 'dependency upon the scientific experts as the certified public authorities on the issue' (Wynne, 1992, p. 299). It is suggested that these central blogs in particular are not only acting as translators between scientific research and lay audiences, but, in their reinterpretation of existing climate science knowledge claims and critique of scientific institutions, are acting themselves as alternative public sites of expertise for a climate sceptical audience.

Several reasons may explain why scientifically-based challenges to, or reinterpretations of, climate science, as well as arguments that criticise systems of scientific enquiry or quality, are highly valued in this context. These blogs may be regarded as providing more accurate or trustworthy knowledge than exists in mainstream climate science, or indeed is available either as readily or in as detailed a format as in other sources such as the mainstream media (Boykoff, 2013). This rationale would suggest that the 'relevant resource' that Brass (1984, p. 520) identifies as critical as to why certain nodes become more powerful than others is, in this instance, command of scientific knowledge, in particular, knowledge that attempts to destabilise mainstream science. Bloggers are thus acting as gatekeepers and interpreters in an alternative knowledge network that is running in parallel to the ways in which, for example, scholarly journal editors carry out the same function in the mainstream academic knowledge network (McGinty, 1999). These blogs therefore may be seen to provide a resource upon which scepticism—which, as the literature suggests, is very likely related to processes such as motivated reasoning and disputes of underlying values or worldviews (Boykoff and Olson, 2013; Heath and Gifford, 2006; Lewandowsky et al., 2012; McCright and Dunlap, 2011)—can be scientifically justified (Cook et al., 2004). It is possible that this contributes to a situation whereby these blogs serve as an "echo chamber", within which users are 'consuming news that mesh with their worldview and ideology' (Boykoff, 2013, p. 15), and thus contributing to Hoffman's (2011b) concept of a logic schism within the climate debate. Nonetheless, it is important to note that this research has explicitly aimed to avoid judging the validity of the scientific arguments contained within the blogs in question. It has also been outside the scope of this paper to investigate the latent rationales behind the existence of sceptic opinions held by the specific bloggers identified within the network. However, by highlighting how the use of scientific language and framings (i.e. *how* bloggers are talking about climate change, rather than necessarily *why* they are using those framings to make their arguments) is contributing to the relative positioning of blogs in the climate sceptical blogosphere, such as JoNova's reference to arguments of scientific quality as a means to validate her argument, this paper does aim to contribute to wider debates about the interaction between the public and more traditional forms of expertise (Collins and Evans, 2002; Demeritt, 2006; Wynne, 1992).

This research has also contributed to the literature on online knowledge networks by showing that these central blogs may also be attempting to break open Latour and Woolgar's (1986) "black box" of science, with the lack of deference given to mainstream climate science possibly attributable to the medium of contestation. The internet enables a dramatically different type of social interaction between what Nowotny (1993, p. 308) terms 'knowledge experts and protoexperts', with the minutiae of the building blocks of scientific argument, particularly visual representations such as graphs and diagrams, laid bare for detailed, and rapid, critique. Ravetz (2012) even goes so far as to argue that the blogosphere has actualised post-normal science, with debates about quality—particularly quality related to scientific work—a central tenet. The freely accessible nature of blogs is also notable, as while there is a movement in academia towards open-access journal

publication (Chan, 2004), it is not yet the norm. This is significant as blogs are an increasingly common source of scientific source material for mainstream media (Brumfiel, 2009) and the climate sceptical arguments emphasised in these central blogs likely receive a disproportionately larger audience than is warranted when compared with the knowledge claims made by the majority of mainstream climate science (Boykoff, 2013).

Many opportunities exist for further research using this dataset, including examining discursive links between the blog posts (Bruns et al., 2011), or dialogical analysis when a specific scientific knowledge claim is debated by more than one blog. Investigating the transformation of an issue through this process of debate could point to ways in which participants in the climate debate are framing particular issues of contention. Another extension could be to examine the linkages between climate sceptical and non-sceptical blogs, following the example of Adamic and Glance (2005) who examined linkages between Democrat and Republican political blogs in the run-up to the 2004 USA Presidential election. Finally, it remains unclear what the centrality of these blogs means in terms of their "power" as suggested by Brass (1984), as regards their reach outside beyond the online environment. While blogs in other areas have been suggested as playing an important public agenda-setting role (see for example research by Wallsten (2007) on political blogs in the USA), more research is required that investigates how the climate sceptical blogosphere may be influencing the wider public debate about climate change.

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Figure 1: The climate sceptical blogosphere, where round nodes are category 1 (openly sceptical) and square nodes are category 2 (self-proclaimed “open-minded”).

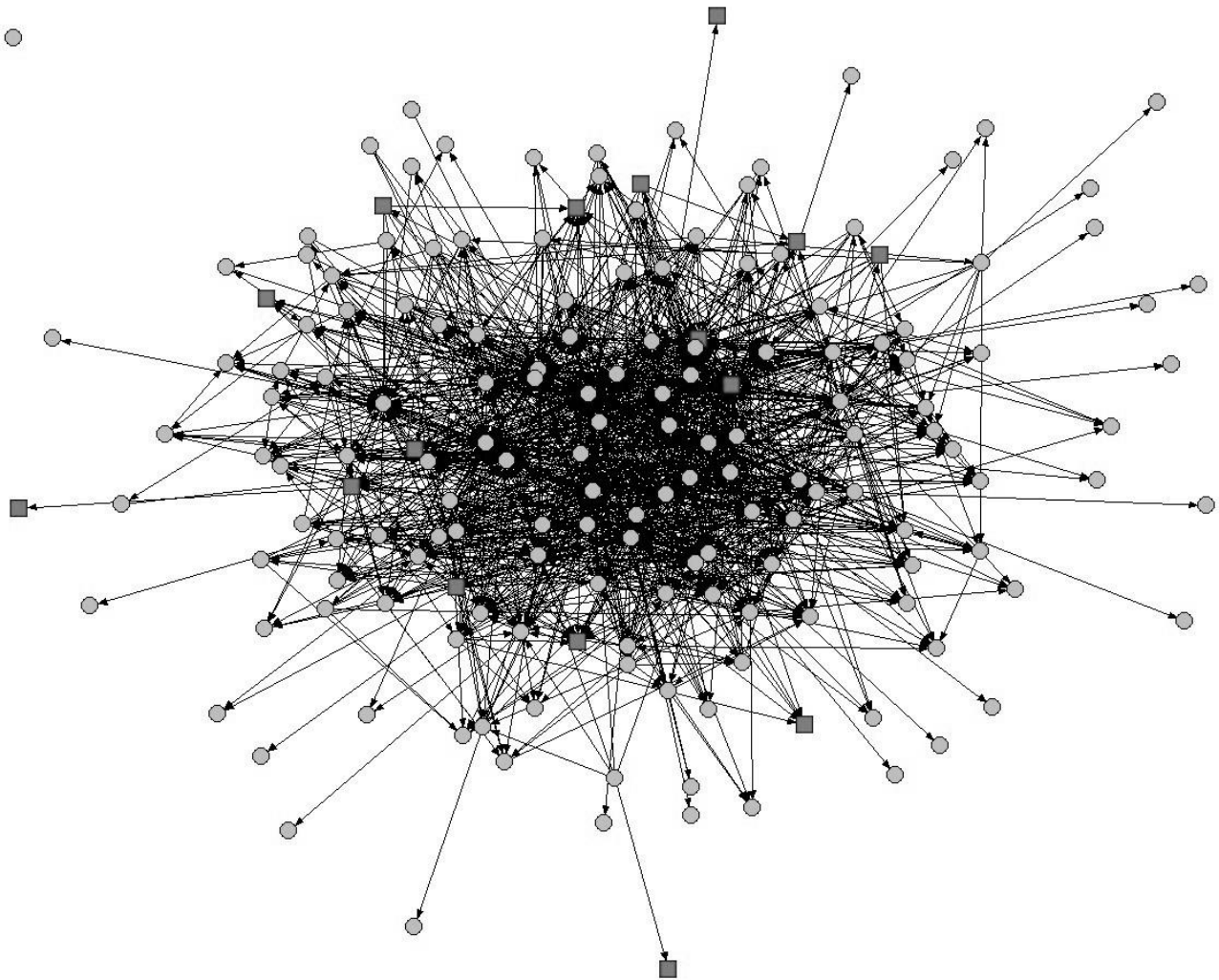


Table 1: Category 1 and 2 language

<i>Blog</i>	<i>About</i>	<i>Post excerpt</i>
Climate etc.	'Climate Etc. provides a forum for climate researchers, academics and technical experts from other fields, citizen scientists, and the interested public to engage in a discussion on topics related to climate science and the science-policy interface.'	'In the case of main stream climate science, the physical mechanism for climate change is clearly posited as arising from external forcing: solar, volcanoes, anthropogenic greenhouse gases and aerosols. However, climate scientists have not racked their brains anywhere near hard enough to come up with other causal explanations. The main outstanding causal explanation that has been neglected is internal natural variability of the coupled ocean/atmosphere system.' (<i>Pseudoscience?</i> , 20 March 2012)
GORE LIED	'The main point here at GORE LIED is that Al Gore lied about anthropogenic global warming. It's pretty simple. I repeat that often, and prove it over and over. While that is my main quest, I also hope to entertain you along the way...The Climategate scandal has proved that the data that comprised the foundation for anthropogenic global warming is fraudulent, and as a result has tainted virtually every other study, conclusion, and public policy "solution" that had been produced or proposed. Therefore, GORE LIED firmly believes that Al Gore, and any other scientists or governmental officials that continue to fan the flames of man-made global warming alarmism to stoke public support for "solutions" that prove to enrich them in money or power be held legally liable for foisting a fraud on the public.'	'Joe Romm asks his readers, "What are you doing to prepare for climate impacts?" The beneficial-molecule-fearing Rommulans obediently reply in droves. One particular comment from a warmist blogger goes a bit beyond the question Romm posed, and predicts a very dark solution for an imagined future climate hell: <i>I'll also predict that laws permitting euthanasia will become commonplace in about two decades. The world will have to choose between keeping the old and ill fed and alive, and keeping the young and fit fed and alive. (Hopefully I'm exaggerating slightly in the second sentence, but maybe not.)</i> So, he might be exaggerating a bit about the choice of exactly who to euthanize, but he's <i>not</i> exaggerating about the actual euthanasia itself. Some of these people have lost their minds.' (<i>Climate death panels? Warmist blogger predicts 'laws permitting euthanasia will become commonplace in about two decades'</i> , 28 February 2012)

Table 2: Centrality tests

<i>Test</i>	<i>Description</i>	<i>Detail</i>	<i>Most central blogs according to test results</i>
Degree centrality (Freeman's approach)	Measurement of incoming and outgoing linkage (also known as in- and out-degree rating).	In-degree rating determines the most linked-to blog. Out-degree rating determines which blogs' blog-rolls are the most extensive.	<ul style="list-style-type: none"> • Bishop Hill • WUWT
Degree centrality (Bonacich's approach)	Measurement of centrality and power according to number of connections within the network.	A positive co-efficient of 0.5 determines centrality. Centrality is achieved if the blogs that are linked to on a blog-roll have themselves many subsequent links. A negative co-efficient of -0.5 determines power. Power is achieved if a blog is connected to many blogs without further links themselves.	<ul style="list-style-type: none"> • GORE LIED • The Friends of Carbon Dioxide • The Global Warming Heretic
Betweenness centrality	Measurement of centrality that shows those nodes upon which others depend to make connections.	A blog is central if it is situated on the shortest path between other pairs of actors in the network.	<ul style="list-style-type: none"> • Climate Audit • JoNova • ICECAP • No Frakking Consensus

Table 3: Degree centrality (Freeman's approach) in-degree results

<i>Rank</i>	<i>Blog</i>	<i>Score</i>	<i>Category</i>	<i>Blog-roll</i>
1	Watts Up With That	93	1	Yes
2	Climate Audit	76	2	Yes
3	JoNova	55	1	Yes
4=	Bishop Hill	46	1	Yes
4=	ICECAP	46	1	Yes
6	Tom Nelson	42	1	Yes
7	No Frakking Consensus	37	1	Yes
8=	JunkScience	34	1	No
8=	Science and Public Policy Institute	34	1	Yes
10=	Climate etc.	32	2	Yes
10=	Climate Realists	32	1	No
10=	Roy Spencer	32	1	No
10=	the reference frame	32	1	No

Table 4: Degree centrality (Freeman's approach) out-degree results

<i>Rank</i>	<i>Blog</i>	<i>Score</i>	<i>Category</i>	<i>Blog-roll</i>
1	C3 Headlines	67	1	Yes
2	GORE LIED	57	1	Yes
3	Global Warming Science	51	1	Yes
4	Climate Change Dispatch	43	1	Yes
4=	Global Warming: A Worn-Out Hoax	43	1	Yes
6	Web Commentary	42	1	Yes
6=	Bishop Hill	42	1	Yes
8	Climate Research News	38	1	Yes
9=	ecomyths	36	2	Yes
9=	Watts Up With That	36	1	Yes
9=	Rajan's Take: Climate Change	36	1	Yes

Table 5: Degree centrality (Bonacich's approach) positive coefficient (centrality) results

<i>Rank</i>	<i>Blog</i>	<i>Score</i>	<i>Category</i>	<i>Blog-roll</i>
1	The Friends of Carbon Dioxide	50.48	1	Yes
2	iloveCarbonDioxide.com	27.45	1	Yes
3	The Global Warming Heretic	21.08	1	Yes
4	Impact of Climate Change	20.34	1	Yes
5	hauntingthelibrary	19.54	1	Yes
6	Tory Aardvark	19.53	1	Yes
7	CO2 Insanity	18.96	1	Yes
8	Climate Change Denier	18.88	1	Yes
9	Global Warming	18.81	1	Yes
10	An Honest Climate Debate	17.68	1	Yes

Table 6: Degree centrality (Bonacich's approach) negative coefficient (power) results

<i>Rank</i>	<i>Blog</i>	<i>Score</i>	<i>Category</i>	<i>Blog-roll</i>
1	Climate Nonconformist	-430.62	1	Yes
2	Global Shamming	-324.14	1	Yes
3	False Alarm	-280.37	1	Yes
4	The Global Warming Heretic	-222.19	1	Yes
5	Kiwi Thinker	-200.96	1	Yes
6	The Friends of Carbon Dioxide	-192.02	1	Yes
7	Errors in IPCC Science	-182.42	1	Yes
8	Climatequotes.com	-175.84	1	Yes
9	Digging in the Clay	-160.21	1	Yes
10	GORE LIED	-159.55	1	Yes

Table 7: Freeman's betweenness node centrality results

<i>Rank</i>	<i>Blog</i>	<i>Score</i>	<i>Category</i>	<i>Blog-roll</i>
1	Watts Up With That	3971.52	1	Yes
2	ICECAP	2638.08	1	Yes
3	Bishop Hill	1948.08	1	Yes
4	Global Warming Science	1805.80	1	Yes
5	No Frakking Consensus	1790.30	1	Yes
6	GORE LIED	1672.28	1	Yes
7	C3 Headlines	1365.88	1	Yes
8	Climate Audit	1221.18	2	Yes
9	JoNova	1084.35	1	Yes
10	Australian Climate Madness	1016.16	1	Yes

Table 8: Estimated site traffic using Google Ad Planner

<i>Blog</i>	<i>Estimated unique visitors per month</i>	<i>Estimated page views per month</i>
Climate Audit	19,000	200,000
ICECAP	14,000	84,000
JoNova	22,000	200,000
WUWT	140,000	2,100,000