

Brian Trench

Scientists' blogs: glimpses behind the scenes

1 Introduction

Scientists operate in an Internet-saturated environment and their pervasive use of email and the web for professional and public communication and, in particular, the implications of the web's adoption for scholarly publishing have been the object of much professional discussion and formal analysis over more than a decade (e.g., Rzepa 1998; Peterson 2001; Dumlao and Duke 2001). But scientists' use of more conversational Internet media, specifically web logs (blogs), has not been examined as much. Much of the commentary that has been published on blogs in and about science comes from practitioners who are strongly committed to promoting this kind of communication. In this chapter, we aim to take a more dispassionate view of the extent and effects of science blogging in the context of the increasing mediatization of science and changes in professional scientific and public science communication driven by media-technological developments. We take mediatization to refer to scientists' and scientific institutions' increased and significant attention to media dimensions of their work and their increased and significant adoption of mass-media genres and platforms in their communication.

We will consider the growth of science blogging, and particularly scientists' blogging, as part of the developing blogosphere and offer a characterisation of scientists' blogs, focusing in more detail on particular disciplines. In developing this characterisation we will give special attention to the insights that scientists' blogs may give on the media orientation of science, such as mediatization theory posits. We will also consider the role that scientists' blogs play in opening access to the inner workings of science; in this, we are interested to establish whether blogs as a means of personal expression facilitate public understanding of science-in-the-making.

In reviewing science blogs we were interested to establish what support, if any, could be found for the observation of nearly a decade ago that the web "opened up many aspects of scientific research previously hidden from the general public" (Peterson 2001) or for the notion of the Internet "turning science communication inside-out" (Trench 2008). Here it was postulated that Internet communication, in opening to public view previously closed private spaces, blurs the boundaries or restructures the relations between these spheres. Blogs, with their personal, even intimate, character appear strong candidates for facilitating this 'inside-out' process.

This interest in blogs as windows on previously private spaces relates to several well-known propositions on the social organisation and social relations of science that all draw implicitly or explicitly on Goffman's (1959) work on the back-stage and front-stage presentation of self. All also, to one degree or another, stress the importance of gaining access to and understanding of the back-stage preparation for the front-stage performance. These include Hilgartner's (2000) elaboration of performance, theatrical and staging metaphors in relation to scientists' participation in public debates and Latour's (1987) view of science as Janus-faced, with two faces of ready-made science and science-in-the-making. Latour focused on securing entry "through the back door" of science-in-the-making as of greater interest in understanding the social constitution of science. Durant (cited in Gregory and Miller 1998) suggested that scientific literacy could be considered as knowing many facts of science, knowing how science works, or knowing how science *really* works and focused his attention on the last of these: "What [the public] needs, surely, is a feel for the way that the social system of science actually works to deliver what is usually reliable knowledge about the natural world". In this, Durant can also be interpreted as advocating the need for public appreciation of what goes on back-stage in science.

The editors of this present collection draw on the same lexicon in their discussion of the concept of medialization (see Franzen et al., this volume) when they ask if science's orientation to the mass media remains "limited to activities on the front stage produced for public view or does it extend to the back stage, thus affecting the criteria of relevance in knowledge production?" Sociologists have applied ethnographic and other methods to see what is happening back stage in science. The development of Internet media, and, in particular, of blogs appears to provide a readily accessible means to look behind the scenes. In this chapter, we are interested to see if communication in this hybrid private/public space of blogs has a bearing on the conduct of science itself. In his discussion of mediatization, Valiverronen (2001) notes:

"Communicating science to the general public may influence the mechanisms of science, and not only in the level of funding, science disputes or in the public legitimization of science. Public discourse also feeds back into science-in-the-making."

The case of climate science blogging that will be discussed in this chapter offers specific answers to the editors' questions above and some confirmation of Valiverronen's view of public communication affecting the conduct of science. Pearce (2010b) opens his extended investigation of the 'Climategate' affair with a chapter entitled "Windows on a closed world" and writes in his concluding chapter: "The doors of the labs are being opened, whether scientists like it or not". As we shall explore further in part 5 of this chapter, climate science represents a special case of highly mediatized science in which blogs have played an important constitutive role.

The following sections of this chapter trace the short history of science blogs, with particular reference to blogs published by scientists (section 2), consider

some of the claimed impacts of scientists' blogs on the conduct and governance of science (section 3), set out some general characteristics of scientists' blogs (section 4), review the intense discussions of climate science in the blogosphere and the role of blogs in the 'Climategate' affair (section 5) and discuss the factors constraining scientists' adoption of blogs in their peer-to-peer and public communication (section 6).

2 The Slow Growth of Science Blogging

The growth of blogging since the early 2000s has been dramatic. Total weblogs were estimated at about one million in 2003 and over four million in 2004. Another two years later, the Pew Internet and American Life Project (2006) reported that 8% (12 million) of 147 million adult users of the Internet in the United States kept a blog, while 39% (57 million) read one. By late 2006, the specialist web site Technorati.com was "tracking more than 57 million blogs and counting" (Sifry 2006). In 2008, the same source gave the total number of blogs as 133 million (Sifry 2008).

Free blogging software reduced the entry-cost to zero and the entry-time to minutes and helped drive blogging as a near-mass phenomenon. By 2004, the accumulated blogs were being referred to as a collective space, the blogosphere, meriting analysis in a special issue of the computing journal *Communications of the ACM* (December 2004). *Business Week* writers Baker and Green (2005) described blogs as "simply the most explosive outbreak in the information world since the internet itself" that would "shake up just about every business". Interviews with bloggers associated with Stanford University revealed that bloggers' primary motivations were to document one's life, to provide comment and opinion, to work out emotional issues and to promote conversation (Nardi et al. 2004). But bloggers were also credited with breaking major political stories in the United States (Rosenbloom 2004). Rosenbloom noted that technological research disciplines were well represented among blogging communities and, more recently, Davidson and Vaast (2009) suggested that "tech bloggers may act as an active minority within technology-focused discourse communities and, in doing so, influence social representations of ICTs within society".

A study of medical bloggers (Kovic et al. 2008) noted that survey respondents' motivations for blogging were different from the generality of bloggers: "Sharing practical knowledge and skills, as well as influencing the way other people think, were major reasons for blogging among our medical bloggers, but not among general bloggers".

Another such study (Lagu et al. 2008) concluded that medical blogs were "now part of the literature and media of medicine" which in the authors' view ranged from professional and scientific publications to medical dramatizations on television. The authors expected the importance of medical blogs to grow but they also

noted that “authors of some medical blogs censor their thoughts and comments less than we expect they would in traditional public settings”.

Science blogging has also attracted attention in academic and professional journals. Batts et al. (2008) described science blogs as having “carved out a small but influential niche”. A report in *The Guardian* (McClellan 2004) offered an early view of blogging by academic researchers, but the cases cited were in popular culture, literature, political philosophy, informatics and cyberculture, not in the natural sciences. In the following year, a *Nature* report (Butler 2005) suggested there were “still only a few dozen scientific bloggers”. Hannay (2007) described scientific blogging as “still a niche activity” and stated that “scientists have been relatively slow to fully embrace [the web’s] potential ... among a few million scientists worldwide, only perhaps one or two thousand are blogging, at least about science”.

Batts et al. estimated the total number of science blogs at “over 1,200”, drawing on a study published a year earlier that in turn quoted science blogger Bora Zivkovic as estimating the number of science blogs at 1,000–1,200 (Bonetta 2007). A more recent estimate (Mooney and Kirshenbaum 2009) was “some 1,000”, though this was qualified as “undoubtedly a very conservative figure”. Several science bloggers who responded to a survey by *Nature* blogger Martin Fenner (2008) said they expected there to be many more science blogs in five years’ time as it becomes “more socially acceptable”, or, according to one respondent, “so many science blogs that we have to specialise”.

Because the definition of science blog or scientist blogger can never be unequivocally settled the numbers cannot be precise. The distinction between science blog and scientist blogger is of some significance, however: authors of blogs that are mainly or exclusively about science include graduate students, science journalists and science writers; qualified scientists may not be in a majority of those behind science blogs. What seems clear is that there are less science blogs and certainly far less scientists’ blogs than the numbers of scientists in the world’s Internet population would indicate. As has been previously observed in studies of science web sites (Massoli, 2007; Trench 2008, 2009), scientists and their institutions have tended to use the Internet mostly for professional communication and, where wider publics are in mind, for dissemination of scientific findings and for promotion of science to students, policy-makers, media, business partners and prospective employees. Blogging and other more highly interactive applications of the Internet do not fit comfortably into that set of priorities. However, these observations do not deprive science blogging of all importance. In certain sectors of science where, for example, knowledge is especially uncertain or controversial, science blogging may have a weight that is not measured in the total number of science blogs in the total blogosphere. This may also be true for sectors of science where there is a relatively high level of public, or amateur, participation. We will consider examples of such cases in later sections.

3 Uses and Impacts of Science Blogging

In discussion of science blogs claims have been made on how science blogging has influenced the practice of science itself. Science blogging has been reported as a means by which scientists have found collaborators for the authoring of significant papers (Batts et al. 2008) or have benefitted from “interesting perspectives” of site users’ comments, even helping to generate “new research ideas” (Butler 2005). However, it is notable that examples given by commentators of significant impacts of blogging on the conduct of science tend to be repeated, suggesting there may not be very many such examples: The story of a PhD student in genetics, Reed Cartwright, who disagreed in his blog with a 2005 *Nature* paper and was then invited to be co-author of a paper for *Plant Cell*, has been told in *The Scientist* (Secko 2007), by Bonetta (2007) and by Batts et al. (2008).

Science blogging has also been presented as a means of “enabling a conversation between the science community and the general community” (Elliott 2006) as a way to interact with a wider audience of peers and public (Butler 2005), and as having a powerful “capacity to put a human face on science and related health issues by allowing scientists to discuss how these things affect them personally” (*Nature Methods* 2009). It has been claimed that the notably successful blog Pharyngula has become a “universal, interactive rallying point for understanding and discussing evolutionary development” (Batts et al. 2008), making its originator, P. Z. Myers, a “rock star of scientist bloggers” (Bonetta 2007), also through his advocacy of science-based atheism.

Much of the analysis of science blogging has been written by enthusiasts or by observers who are also practitioners. Batts et al. (2008) set out an argument for research and academic institutions to adopt blogging actively as part of their practice. Tola (2008) considered

“the advantages of this medium are so self-evident, in terms of the possibility of gaining feedback on one’s work and approaches, of finding new solutions and ideas, of meeting new colleagues and other scientists who might be contributing to the development of one’s research, of starting new collaborations, even of finding new positions, that it is really difficult to imagine why a scientist, especially a young one at the beginning of her own career, should not feel like entering this collective conversation”.

Wilkins, a philosopher of science and blogger (Evolving Thoughts), describes science blogging as personal, ephemeral, and “more intimate and responsive” than other forms of science communication (2007). Schmidt, a climate scientist and blogger (Realclimate.org), sees blogs as a way for scientists to talk to the public directly, casually and in depth about complicated and contested scientific topics (Gramling 2008).

This merging of professional and public spheres of communication, without the intermediation of journalists, has been represented as one of facilitating public peer review (Batts et al. 2008), or of harnessing “collective intelligence” and “wisdom of the masses” (Minol et al. 2007). By analogy with “Web 2.0” – the

purported new face or phase of the Internet that is genuinely interactive and participatory, and of which blogs are a representative expression – “science 2.0” is sometimes invoked to refer to a collective, inclusive endeavour in which both citizens and experts are engaged (Waldrop 2008).

Some commentary on the Climategate affair sees in it the emergence of “extended peer review”. Jerome Ravetz, who coined that phrase almost two decades ago with Silvio Funtowicz in their elaboration of ‘post-normal science’ (Funtowicz and Ravetz 1993), said of the climate science debate that it demonstrated the need for and inevitability of such public scrutiny:

“It is hard to see how this extended peer community of the scientific blogosphere could be silenced or suppressed, once it has shown its power. Doubtless it will be vulnerable to misuse and abuse, just like democracy in the political sphere, and so it will need guidance ... and courtesy” (cited in Pearce 2010b).

Similarly, journalist and blogger Patrick Courrielche (2010) believes Climategate “triggered the death of unconditional trust in the scientific peer review process” and the maturing of a new movement of peer-to-peer review.

However, it is clear that the potential of science blogging to significantly affect communication among scientists and relations between scientists and lay publics depends to some degree on the level at which blogging and other more highly interactive Internet media have been adopted in science. Physicist Michael Nielsen (2009) observed that “scientists have been relatively slow to adopt online tools such as comment sites and Wikipedia”. Waldrop (2008) noted, “although wikis are gaining, scientists have been strikingly slow to embrace one of the most popular Web 2.0 applications: Web logging, or blogging”. He quoted Christopher Surridge, managing editor of the Web-based journal *Public Library of Science On-Line Edition*, as saying that “scientists don’t blog because they get no credit” and this was echoed in the comment of *Nature’s* editorial writer (*Nature* 2009) that “blogging will not help, and could even hurt, a young researcher’s chances of tenure”.

What the available literature indicates is that, despite strong advocacy of the merits of blogging in science and some notable instances of highly visible scientist bloggers, scientists are significantly under-represented among bloggers in general and little evidence has been reported of blogging having a tangible impact on the conduct of science.

4 Features of Scientists’ Blogs

To form an overview of the characteristics of scientists’ blogs, in early 2010 we reviewed 20 such blogs that were frequently mentioned in commentaries on science blogs or in listings of ‘top science blogs’. The sites reviewed included well-known blogs such as Pharyngula, NASA Watch, Blog Around the Clock, Bad Astronomy, Cosmic Variance and Highly Allochthonous. As explained be-

low, blogs primarily concerned with physics, nanotechnology and climate science were also reviewed as separate sub-groups. A study of the modes of communication in 11 science blogs (Kouper 2010) included some also among our core group of 20 and concluded that

“they provide information and explain complicated matters, but their evaluations are often trivial and they rarely provide extensive critique or articulate positions on controversial issues ... In their current multiplicity of forms and contents science blogs present a challenge rather than an opportunity for public engagement with science”.

Kouper’s study emphasised differences between different branches of the sciences as factors in the heterogeneity of science blogs.

Our review of scientists’ blogs was guided by general considerations of good practice on the web, including those of authorship, sources, content, frequency, usability and interactivity. We found great diversity in the frequency of updates (from several times daily to less than monthly), in the types of sources used (more often general media than scientific media), and in the types of information featured (dealing more often with contexts of science such as publishing, ethics and policy, than with science content). In view of the overriding concerns of this chapter we focused on issues of interactivity – the scope and quality of exchanges between blog publishers and visitors – and of transparency of scientific process – that is, the public access provided to negotiation of different views and of uncertainty in scientific information (or “science-in-the-making”).

In relation to the quality of discussion, we noted that blog-owners could generally be identified, along with their professional affiliations or lack of affiliation but other contributors to the sites included some who were identified by arbitrary user names. In some cases, it appeared that regular visitors to a blog have come to know each other and the identity of the person behind the user name. This can engender unbalanced exchanges, in which the identities and credentials of the participants are not universally known.

We also noted the kinds of topics that stirred most comment and any tendency for discussion to get heated and to focus on how the argument is made, and who is making it, over the substance of the issue. This criterion relates to the frequently observed tendency of Internet discussions to deteriorate to *ad hominem* argument, a tendency we assumed would be a significant deterrent to scientists’ participation. We found that the topics prompting most comment tended to be well-known as controversial in broader public and media spaces, e.g., science and religion, the hacked climate science emails, alternative medicine and the Obama administration’s policy on the US space programme. But it was noted that in a majority of cases, even the most-commented postings elicited less than 20 responses. The low level of discussion and the absence of debate were the most frequently made observation in relation to this criterion and that concerning the nature of debate. Where significant debate was found it was generally well-mannered. As we shall see later, this did not apply in the case of climate science or, indeed, in physicists’ discussions of the activity of blogging itself.

It has been claimed that blogs open “windows into academic coffee room chatter of the sort the media is not normally privy to” (Tomlin 2007) and it has been argued that blogs, in making this possible, serve an important function because, “unlike laws and sausages, the public should see science during its manufacture” (Wilkins 2008). But we found that less than a quarter of the blogs provided even occasional looks behind the scenes of science. Several of the blogs that did so were focused on relatively abstruse areas of physics. For this reason, the review of physics blogs was extended.

Concern has been expressed in physics circles that “physicists may be getting left behind” in comparison with other researchers using blogs and wikis (Griffiths 2007), but the same author also claimed that physics blogs were “starting to have a real impact on the way researchers communicate” (Griffiths 2007). We observed fairly frequent links between blogs and formal publications on the arXiv pre-print physics publishing site. These offered relatively rare examples of blogs facilitating public view of science-in-the-making. In February 2010, for example, the arXiv blog provided access to vigorous exchanges between physicists on an arXiv paper predicting an 11-fold increase in hurricane activity with a 2-degree rise in global temperature. The commenters countered claims of “pure hype” and “tailoring the data” with claims of “good science” and “clear model”.

The public visibility of this debate might be taken as an example of what the physics blog Cosmic Variance aims at, that is, “building bridges between the world of specialists and interested outsiders. Blogs offer both immediacy and unfettered access to the inner workings of mysterious vocations of all sorts, which is hard to get from more formal journalism” (Carroll 2007). In February 2010, Cosmic Variance co-publisher Sean Carroll wrote critically on a *New York Times* report of findings from Brookhaven Laboratory’s Relativistic Heavy Ion Collider that were claimed to have “broken” the laws of physics, specifically the law of parity. His posting prompted dozens more that politely disagreed. Anybody browsing science blogs could observe the fact of this disagreement among physicists, if not necessarily understand its basis.

Astrophysicist Clifford X’s blog, Asymptotia, drew 10,000-plus comments over its first three-and-a-half years of operation in response to his invitation to “engage in conversations with me [and] ... with other commenters”. The conversations sometimes become heated, including accusations of misrepresentation, even around very abstract theoretical topics. Brazilian physicist Christine Dantas closed her blog, Background Independence, in November 2006, explaining that she was uncomfortable with the way her contributions to debate on string theory were represented (Griffiths 2007). Chad Orzel (Uncertain Principles blog) declared in 2007 that he was “fairly disgusted” with the “antics” of string theory blogs and, in February 2010, announced that he would suspend writing his own blog for Lent, declaring that “reading blogs is pissing me off to no good end”. There was criticism of Orzel for his “self-aggrandizing public display” but also support, including a comment that blogs “although potentially capable of generating productive conversation, tend towards bloggers shouting their opinions on the rooftops”.

The evidence here of early disaffection or fatigue with blogging mirrors the short experiment by a well-known particle physicist in another form of so-called 'social media'. Brian Cox, a young English physics professor with a very strong mass-media profile, started podcasts on the CERN web site in 2007 and, despite securing the co-operation of high-profile interviewees, ceased this activity in 2008.

As a field of scientific research and technological development that is still taking shape, nanotechnology appeared as a strong candidate for public discussion of its procedures and its possibilities, including its risks. However, the main content of the frequently cited Soft Machines blog comes in the form of mini-essays on the fundamentals of nanotechnology and on topics of science in society. Many other nanotechnology-focused blogs are more strongly promotional in orientation: Nanotech-Now and Nanotechbuzz are primarily vehicles for nanotechnology business news.

Nanotechnology also features strongly in blogs that present perspectives on future trends: Nanodot is maintained by the Foresight Institute and covers artificial intelligence and robotics as well as nanotechnology business stories; Singularity Hub, Accelerating Future and Next Big Future present speculations on technological futures and generally optimistic accounts of technological research and innovations.

A common feature of these nanotechnology or futures blogs is the low level of comment and the almost complete absence of critical debate on nanotechnology. These issues are aired, however, in CRNano, a blog maintained by the Centre for Responsible Nanotechnology that is dedicated to promoting awareness of the benefits and risks of nanotechnology and to promote "wise, comprehensive, and balanced plans for responsible worldwide use of this transformative technology".

The possible risks in nanotechnology were also aired in the frequently mentioned Nanobot blog, owned by journalist Howard Lovy, who shared his concerns about some of the hyperbole surrounding nanotechnology. This blog started in late 2003 and had its highest level of posts (over 500) in 2004. But in another demonstration of early disaffection with science blogging Lovy closed the blog in mid-2009, declaring his disillusion with internet communication of science: "I have already rejected Web 2.0. I am almost ready to tell Web 1.0 to get lost as well."

From these reviews we can observe that scientists' blogging presents a diversified picture but even within this diversity we find very little evidence to support the claims reported above of blogging's significant role in communicating science or its significant impacts on science. The most notable evidence of blogs playing an important innovative role in communicating science by facilitating public view of science-in-the-making was found in physics, perhaps paradoxically in aspects of that discipline where there was very little of obvious public value at stake in commercial, ethical or political terms. It was in physics, too, that some evidence was found of blogging playing a substantive constitutive role in the science itself. In both of these regards, the picture is different when we turn to climate science blogging.

5 The Special Case of Climate Science

Climate science is uncertain in its interpretations of historical records and pre-historical evidence, it is necessarily speculative in extrapolation to future trends, it presents knowledge that has strong political and ethical implications and its collective wisdom is represented globally on a quasi-political platform, the Intergovernmental Panel on Climate Change (IPCC). For these and other reasons, climate science is notably attractive to media and has become especially attuned to the logics of mass media and actively concerned with ensuring appropriate media coverage. Media attention to climate science has been consistently high in recent years; it is also notably diverse and diffuse, covering the full range of older mass media – newspapers, magazines, television, radio – as well as the full range of newer digital and online media – electronic publishing, institutional and personal web sites, blogs, forums and social networking sites.

However, formal studies of media representations of climate science have tended to concentrate on ‘traditional’ media: In their analysis of media coverage of climate change, contributors to an edited volume (Boyce and Lewis 2009) examine almost exclusively print media coverage in various countries; just one contributor (Gavin 2009) focused on the web. Carvalho (2007) examines climate change discourses in three elite British newspapers up to 2001; her study makes no reference to the Internet as a vehicle of disseminating or discussing scientific information about climate change. However, Rogers and Marres (2000) had earlier taken climate change as a case for demonstrating how a mapping technique might be applied to web debates.

Pew Internet and American Life Project (2006) reported that 20% of Americans used the Internet as their primary source of information on science but of those who stated a particular interest in climate change, 49%, the highest proportion of the subject ‘specialists’, had received information on climate change from the web or by email. Gavin (2009) examined what information citizens had available to them on the web relating to climate change politics. He noted the large quantity of information and comment accessible on the web but he lamented the quality of what he found on blogs:

“The contributions do contain moderate exchanges of evidence and argument, but there are high numbers of controversial and uncheckable assertions ... Entries are often highly disjointed and difficult to follow – part polemic, part rant, part ramble, part squabble, and often involving people flatly contradicting or sniping at one another.”

If that represented the whole story of climate blogging, it would be easily dismissed. But in late 2009 and early 2010, climate science was thrust into the public spotlight as perhaps never before and communities of bloggers played tangible roles not only in how it was publicly received, but also in how it was constructed internally. Nearly three years after its publication, the Fourth Assessment Report (AR4) of the Intergovernmental Panel on Climate Change (IPCC) was scrutinised with new vigour, errors were identified and retractions made, all in the full glare

of mass media and online media attention, and sometimes directly triggered by media initiatives.

These developments followed a November 17, 2009 posting by 'FOIA' of a short message on the climate change sceptic blog, The Air Vent. The posting had a link to a compressed data file posted on an Internet server ostensibly based in Russia. The compressed file contained 1,073 emails and 3,587 other documents apparently hacked from the server of the Climatic Research Unit (CRU) at the University of East Anglia in England. The hack of emails appears to have arisen from a series of unmet freedom of information (FoI) requests to the CRU during 2009 for release of data on weather patterns for a long list of named countries. The campaign of FoI requests was run through the Climate Audit blog, where supporters found advice on phrasing the requests and co-ordinated their selection of countries whose climate data was requested.

The pseudonym, FOIA, was tellingly the one used by the person who posted a comment on The Air Vent on November 17, 2009. As it happened, Jeff ID was away from home deer-hunting. He returned to his blogging on November 18 but did not notice until the next day that FOIA's posting linked to hundreds of emails and other internal documents from CRU that represented, in Jeff ID's words, "62 mb (megabytes) of gold".

By the evening of November 19, links to the documents had been posted on several blogs, including Watts Up With That, Climate Audit, Climate Sceptic and The Blackboard. All of these blogs represent views at odds with the IPCC on climate science. Some concentrate on technical aspects of the calculations of global warming, others on the governance of climate science through IPCC, and others on the perceived political plot behind climate change policy.

While Jeff ID took time to reflect on the propriety of making the material generally available, he was overtaken by other bloggers and soon some blogs were struggling with the load. Pearce (2010b) notes that selected emails between climatologists employed by or associated with CRU were reproduced repeatedly for their shock effect. Comments on one blog were amplified through linking to and from many others. From this hyperactive blogosphere it was a short step to online news media, starting with a New Jersey newspaper, *Essex County Conservative Examiner*, but by November 20 also reaching Fox News, *Wall Street Journal*, BBC, National Public Radio and *New Scientist*.

The debate continued in the run-up to the COP15 climate change summit that opened in Copenhagen on December 7. This meeting of political and scientific leaders took place in the media's embrace, including that of blogs and bloggers. 5,000 journalists from 180 countries were accredited to cover the meeting; the majority of these were from media outside the 'mainstream'. The blogs represented there included those of consultancy companies like Deloitte and Arup, energy companies like Vattenfall and The Solar Company, non-governmental organisations like Oxfam, World Wildlife Fund and 350.org, student groups from Rice University, Houston, Texas, and Chalmers University in Sweden, along with diverse media outlets such as Google, *Lloyd's Register* and BBC.

Before, during and after COP15, the work of the IPCC was under an increasingly critical spotlight, not only shone by climate-sceptic bloggers. In early December 2009, BBC News had first reported questions raised about the basis for the IPCC's assessment of the rate of disappearance of Himalayan glaciers. These questions "reverberated around climate web sites" (Black 2010). The *New Scientist* recalled on January 11, 2010 (Pearce 2010a) that in 1999 it had reported a claim similar to that contained in AR4, but referring only to the central and eastern Himalayas. On January 20, 2010, the IPCC issued a short statement that the paragraph in question was "poorly substantiated" and "the clear and well-established standards of evidence required by the IPCC procedures were not applied properly". A week later, the IPCC spelled out in a 1,000-word statement its principles and procedures for compiling assessment reports, including the "meticulous" reassessment of the scientific information contained in AR4. The 'Climategate' affair, as it has become known, could not have grown as it did were it not for the availability of blogs to quickly disseminate information and arguments. Indeed, it might never have happened at all were it not for the active presence in climate science debates of blogger Steve McIntyre (climateaudit.org) who ran a blog-based campaign of freedom of information requests for release of worldwide meteorological data used by CRU in compiling global temperature records. This campaign provided the trigger and the context for the messy process that became Climategate.

The blogosphere debates provoked by the hacked documents and the following process – again, mainly Internet-based – of refutation and subsequent retraction of claims contained in IPCC reports eventually led to the announcement by the United Nations of a review of the IPCC's work. The Inter-Academy Council's review group reported in August 2010 (Inter-Academy Council 2010), making recommendations on more open recognition of the uncertainty of climate science knowledge, on more rigorous review of information taken into IPCC reports and on improving transparency of the IPCC's review processes. Much of the proposed reform of climate science governance and co-ordination through IPCC is due, at least indirectly, to a blog-based campaign to let public light into private, professional spaces.

What may have started as the provocative act of one technically literate individual ballooned through blogs into a global crisis for a branch of the natural sciences that involved several of the world's leading professional societies, the international leaders of the IPCC and the world's highest-placed public administrator. The involvement of the UN Secretary-General underlines the particular character of the climate science debate. But atypical cases can also serve to highlight some general features. The climate science case indicates that the importance of extra-scientific factors in a particular branch of science gave particular importance to science blogs in communicating and influencing the content and conduct of that science. Weingart (1998) noted in an early treatment of the medialization of science that 'science-media coupling' tended to be stronger where political dimensions were prominent in the science. One of his case studies was climate science

and over a decade later in a new digital media environment Climategate reaffirmed the significance of that case.

A detailed investigation of this affair (Pearce 2010b), completed six months after the initial posting of the hacked CRU documents, describes it as much more than a local disciplinary spat:

“It was also a battle for ownership of data, the building blocks of scientific theories, and a battle to open up the closed world of scientific peer review to challenge by outsiders. This was about more even than climate science; it was about the conduct of all science. A battle for the soul of science.”

And it was, almost entirely, a battle fought in blogs.

6 Discussion

Discussions of political blogging seem certain that the blogosphere has become a significant space for political communication, not just in relatively liberal societies where various media play watchdog roles on authority but also, and in specifically different ways, in authoritarian societies where print and broadcast media are heavily restricted. Hughes and Kellmann (2009) noted that during the 2009 Iranian elections “disenfranchised Iranis have often turned to the blogosphere to engage in commentary critical of the regime”. Sunstein noted (2007) that “political blogs are a small percentage of the total, but they are plentiful, and they seem to be having a real influence on people’s beliefs and judgments”. In individual cases that he draws from Hewitt (2005), political blogs have exposed lies or corrected false claims and thereby affected the careers and standing of individual US politicians. However, in a comment that resonates with the discussion above of climate change blogs he notes that debate is polarised in the blogosphere, as blog readers tend to read blogs that resonate with their own point of view, and political blogs tend strongly to link to like-minded blogs.

In Technorati.com’s 2010 survey of bloggers, politics was rated the field of activity on which blogging has the most impact: 46% of the respondents ranked politics first, compared with 5% for science (Technorati 2010). Politics features prominently in discussions of blogs and their impacts, and it may be that the conditions that promote the use of blogs in political communication are precisely the conditions that constrain their use in professional scientific communication and public science communication. Politics is to a high degree concerned with values, beliefs, opinions, feelings and personal experiences and while all of these are present factors in science as in any other cultural sphere, their weight is very considerably less than in politics.

The polarisation of debate to which Sunstein refers is an outcome of differences in values that may be deep-seated: Polarisation comes naturally in politics (except where it is suppressed). The particular contribution of blogs to this process is not origination but amplification. When scientists consider possible paradigm

shifts and when they compete for promotion or for institutional support, differences may be expressed in strong terms but not generally in terms of fixed polarised differences.

As we have observed, the case of climate science is in many respects special: Political and ideological factors are prominently in play, including through the involvement in the public debates of ‘amateurs’ who may have technical competence to follow the arguments but whose main motivation for becoming involved is to fight a cause. By virtue of their involvement but also for other reasons, the general atmosphere of the climate science debate has become very highly charged. This is very evident in the blog debates, where Sunstein’s observation of the development of separate camps in the political blogosphere also applies. The representatives and supporters of different positions group around their poles of attraction and rarely venture directly into the opposing camp.

Prof. Judith Curry, a climatologist from Georgia Institute of Technology, is a rare example of a (qualified) defender of the IPCC who contributes to anti-IPCC blogs. She is specifically concerned that the “debate has deteriorated ... into competing lines of propaganda” (Curry 2010). Her occasional contributions to anti-IPCC blogs appear aimed at defending the possibility of rational, critical debate against the odds and have attracted strong criticism from both sides. She has argued that “ignoring sceptics from outside the field [of professional climate science] is inappropriate. Einstein did not start his research career at Princeton, but rather at a patent office” (Pearce 2010b).

Based on his detailed examination of the Climategate documents and of the responses to their release, Pearce (2010b) considers that they have shown “scientists cutting corners, playing down uncertainties in their calculations, and then veering their tracks by being secretive with data and suppressing dissent”. Scientists should own up to that, he believes.

In other domains, the vehemence and vituperation of contributions to open forums have begun to turn some scientists away from Internet debate. Even a public scientist and active polemicist like Richard Dawkins has found the tone and temper of Internet discussion hard to take. The discussion forum on his web site was closed in February 2010 after he was threatened in violent manner. “There is something rotten in the internet culture”, Dawkins commented (Turner 2010). Behind the cloak of anonymity or pseudonyms personal insults have been thrown. But when climate scientist Roger Pielke investigated the identity of a pseudonymous blog commenter who appeared to threaten his children he found that the culprit was a professor (Turner 2010).

The tone and tenor of Internet debates on science and religion, in which Dawkins is centrally involved, and on climate science are cautions against over-optimistic readings of the potential of science blogs to create a new public sphere, at least the kind of public sphere envisaged by Habermas (1989), in which public opinion can be formed through rational discussion. It was tempting to believe that Internet technologies could be used to create a space in which interested publics and scientists of various backgrounds and orientations could exchange views and

information freely and thus engage in “co-production of knowledge”, as Gibbons et al. (1994) postulate in their account of Mode-2 science. The conversations envisaged among scientists and between scientists and publics are not much in evidence, except in climate science, where such conversations easily degenerate into name-calling or focus on trivial aspects of the issue.

However, some see possibilities for a kind of public peer review through blogs. Paradoxically, we have found indications of such possibilities in the contrasting domains of astrophysics and particle physics, on the one hand, and climate science on the other. Whereas personal value systems are major factors in the production and reception of climate science and amateurs can be significant players, neither of these applies in astrophysics and particle physics. Thus, we have cases in which blogging is a relatively significant aspect of the professional and public communication of science, where social implications have either a very high or very low presence. The case of nanotechnology compounds the paradox: In this emerging science, there are discernible social issues that have been explored through various public engagement initiatives but these appear under-represented in the blog discussions.

The short history of the Internet has been marked by waves of high expectations that it would facilitate the formation of new relationships and communities. Such expectations have been expressed even more vigorously around the development of so-called ‘Web 2.0’ technologies or ‘social media’. Blogs are seen as part of this supposed new era of highly interactive Internet media based on user-generated content. Blogs on science have been presented as a means to create new relations between scientists and lay publics and to support public and peer scrutiny of new developments in science, thus “fundamentally changing the nature of science communication” (Bubela et al. 2010). In some commentaries, however, this view has also been tempered by awareness of the “dubious quality” of much of the information on science available on the web (ibid.) and awareness that “for most scientists and academics, blogs and wikis remain unattractive distractions from their real work” (MASIS Expert Group 2009).

This chapter adds to these cautions, noting the very limited and possibly declining take-up of blogs by scientists, observing the generally low levels of peer-to-peer and professional-to-public discussion on even well-established scientist blogs, but also drawing attention to cases of scientist blogs that have opened new spaces for improving scientific accountability. In this way, it suggests that the mediatization of science in respect of the newer forms of online media is very partial and very uneven. The potential of scientists’ blogging to contribute to reshaping relations between sciences and publics is evident but it appears largely to be an unrealised potential. That may relate to factors in the professional culture of the sciences which deter scientists from engaging in an online medium that is inherently predisposed to personal, affective communication. It would take a different kind of exploration to establish how scientists’ media adoption and adaptation are shaped by their social organisation and institutional cultures.

Acknowledgments The author acknowledges the assistance of graduate student Sean Marshall in the review of general features of science blogs.

References

- Baker, S. and H. Green (2005). Blogs will change your business. *Business Week*, no. 39(31), 56–67.
- Batts, S. A., N. J. Anthis, and T. C. Smith (2008). Advancing science through conversations: Bridging the gap between blogs and the academy. *PLoS Biology*, 6(9), 1837–1841.
- Black, R. (2010). UN climate body admits ‘mistake’ on Himalayan glaciers, BBC News website, posted 19 January 2010, last accessed on March 15, 2010.
- Bonetta, L. (2007). Scientists enter the blogosphere. *Cell*, 129(3), 443–445.
- Bubela, T. et al. (2010). Science communication reconsidered. *Nature Biotechnology*, 27(6), 514–518.
- Butler, D. (2005). Joint efforts. *Nature*, 438 (1 December), 548–549.
- Carroll, S. (2007). Blogging for physics. *Physics World*, January, 14.
- Carvalho, A. (2007). Ideological cultures and media discourses on scientific knowledge: Re-reading news on climate change. *Public Understanding of Science*, 16(2), 223–243.
- Courrielche, P. (2010). Peer-to-peer review: how Climategate marks the maturing of a new science movement, posted at <http://bigjournalism.com/pcourrielche/2010/01/08/peer-to-peer-review-how-climategate-marks-the-maturing-of-a-new-science-movement-part-i/>, last accessed on October 11, 2010.
- Curry, J. (2010). Reflections on climategate. *People & Science*, March, 13.
- Davidson, E. and E. Vaast (2009). Tech talk: An investigation of blogging in technology innovation discourse. *IEEE Transactions on Professional Communication*, 52(1), 40–60.
- Dumlao R. and S. Duke (2001). The web and e-mail in science communication. *Science Communication*, 24(3), 283–308.
- Elliott, S. (2006). Science blogs as a vehicle for upscale ads. *The New York Times* (20 January).
- Fenner, M. (2008). Why do we blog and other important questions, answered by 34 science bloggers, posted on <http://blogs.nature.com/mfenner/2008/11/30/why-do-we-blog-and-other-important-questions-answered-by-34-science-bloggers>, viewed on 11 March 2010.
- Funtowicz, S. and J. Ravetz (1993). Science for the post-normal age. *Futures*, 25, 739–755.
- Gavin, N. (2009). The web and climate change politics: Lessons from Britain. In T. Boyce and J. Lewis (eds.), *Climate change and the media*. New York: Peter Lang, pp. 129–144.
- Gibbons, M. et al. (1994). *The new production of knowledge: The dynamics of science and research in contemporary societies*. London: Sage.
- Goffman, E. (1959). *The presentation of self in everyday life*. Garden City, NJ: Doubleday.
- Gramling, C. (2008). Science bloggers question their role. *Geotimes*, 53(6), 47.
- Gregory, J. and S. Miller (1998). *Science in public: Communication, culture and credibility*. New York: Plenum Press.
- Griffiths, M. (2007). Talking physics in the social web. *Physics World*, January: 24–27.
- Habermas, J. (1989). *The structural transformation of the public sphere – An inquiry into a category of bourgeois society*. Cambridge, MA: MIT Press.
- Hannay, T. (2007). Web 2.0 in science, *CTWatch Quarterly*, 3(3), 19–25.
- Hewitt, H. (2005). *Blog: Understanding the information reformation that's changing your world*. Nashville: Thomas Nelson.
- Hilgartner, S. (2000). *Science on stage: expert advice as public drama*. Stanford, CA: Stanford University Press.

- Hughes, D. and R. Kellmann (2009). Blogging's global impact and the future of blogging, posted at <http://technorati.com/blogging/article/day-5-twitter-global-impact-and/page-2/>, last accessed on March 15, 2010
- Inter-Academy Council (2010). *Climate change assessments – Review of the processes and procedures of the IPCC*. Amsterdam, Inter-Academy Council.
- Kouper, I. (2010). Science blogs and public engagement with science: Practices, challenges, and opportunities. *Journal of Science Communication*, 9 (1), posted at <http://jcom.sissa.it/archive/09/01/Jcom0901%282010%29A02/>, last accessed on December 22, 2010.
- Kovic, I., I. Lulic, and G. Brumini (2008). Examining the medical blogosphere: An online survey of medical blogger. *Journal of Medical Internet Research*, 10(3), posted at <http://www.jmir.org/2008/3/e28/>, last accessed on December 22, 2010.
- Lagu, T. et al. (2008). Content of weblogs written by health professionals, *Journal of General Internal Medicine*, 23(10), 1642–1646.
- Latour, B. (1987). *Science in action – How to follow scientists and engineers through society*. Cambridge, MA: Harvard University Press.
- MASIS Expert Group (2009). *Challenging futures of science in society: Emerging trends and cutting-edge issues*. Brussels: European Commission.
- Massoli, L. (2007). Science on the net: An analysis of the websites of the European public research institutions, *Journal of Science Communication*, 6(3), posted at <http://jcom.sissa.it/archive/06/03/JCOM0603%282007%29A03/>, last accessed on December 22, 2010. McClellan, J. (2004). Inside the ivory tower. *The Guardian*, Online supplement (23 September): 24.
- Minol, K. et al. (2007). Portals, blogs and co.: The role of the Internet as a medium of science communication. *Biotechnology Journal*, 2(9), 1129–1140.
- Mooney, C. and S. Kirschenbaum (2009). Unpopular science. *The Nation* (17 August).
- Nardi, B. A. et al. (2004). Why we blog. *Communications of the ACM*, 47(12), 41–46.
- Nature* (2009). Editorial: Filling the void. *Nature*, 458 (19 March), 260.
- Nature Methods* (2009). Editorial: Lines of communication. *Nature Methods*, 6(3), 181.
- Nielsen, M. (2009). Doing science in the open. *Physics World*, May.
- Pearce, F. (2010a). Debate heats up over IPCC melting glaciers claim, NewScientist.com, posted 11 January 2010, last accessed on March 15, 2010.
- Pearce, F. (2010b). *The Climate Files – The battle for the truth about global warming*. London: Guardian Books.
- Peterson, I. (2001). Touring the scientific web. *Science Communication*, 22, 246–255.
- Pew Internet and American Life Project (2006). The Internet as a resource for news and information about science, posted at <http://www.pewinternet.org/Reports/2006/The-Internet-as-a-Resource-for-News-and-Information-about-Science.aspx>, last accessed on March 11, 2010.
- Rogers, R. and N. Marres (2000). Landscaping climate change: A mapping technique for understanding science and technology debates on the World Wide Web. *Public Understanding of Science*, 9(2), 141–163.
- Rosenbloom, A. (2004). The blogosphere. *Communications of the ACM*, 47(12), 31–33.
- Rzepa, H. (1998). The Internet as a medium for science communication. In E. Scanlon et al. (eds.), *Communicating science: Volume 1 – Professional contexts*. London: Routledge, pp. 141–149.
- Secko, D. (2007). Scooped by a blog. *The Scientist*, 21(4), 21.
- Sifry, D. (2006). *State of the blogosphere*. October 2006, posted 7 August 2006 at <http://www.sifry.com/alerts/archives/000443.html>, last accessed on March 15, 2010
- Sifry, D. (2008). *State of the blogosphere*. September 2008, posted 22 September 2008 at <http://www.sifry.com/alerts/2008/09/technoratis-state-of-the-blogosphere-september-2008/>, last accessed on December 17, 2010.
- Sunstein, C. R. (2007). *Republic.com 2.0*, Princeton: Princeton University Press.

- Technorati (2010). *State of the Blogosphere 2010* at <http://technorati.com/blogging/feature/state-of-the-blogosphere-2010/>, last accessed on December 17, 2010.
- Tola, E. (2008). To blog or not to blog, not a real choice there. *Journal of Science Communication*, 7(2), posted at <http://jcom.sissa.it/archive/07/02/Jcom0702%282008%29C01/Jcom0702%282008%29C06>, last accessed on December 22, 2010.
- Tomlin, S. (2007). Blogging science. *Science & Public Affairs*, September: 23.
- Trench, B. (2007). How the Internet changed science journalism. In M. Bauer and M. Bucchi (eds.), *Journalism science and society*. London: Routledge, pp. 133–142.
- Trench, B. (2008). Internet: Turning science communication inside-out. In M. Bucchi and B. Trench (eds.), *Handbook of public communication of science and technology*, London: Routledge, pp. 185–198.
- Trench, B. (2009). Science reporting in the electronic embrace of the Internet. In R. Holliman, E. Whitelegg, E. Scanlon, S. Smidt, and J. Thomas (eds.), *Investigating science communication in the information age: Implications for public engagement and popular media*. Oxford: Oxford University Press, pp. 166–180.
- Turner, A. (2010). The poisonous pro-am clash in the boffins' blogosphere. *Sunday Times*, 28 February.
- Valiverronen, E. (2001). From mediation to mediatization: The new politics of communicating science and technology. In U. Kivikuru and T. Savolainen (eds.), *The politics of public issues*. Helsinki: Department of Communication, University of Helsinki, pp. 157–177.
- Waldrop, M. (2008). Science 2.0: Great new tool or great risk? *Scientific American*, May: 68–73.
- Weingart, P. (1998). Science and the media. *Research Policy*, 27(8), 869–879.
- Wilkins, J. (2008). The roles, reasons and restrictions of science blogs. *Trends in Ecology and Evolution*, 23 (8), 411–413.