

## Framing the Challenge of Climate Change in *Nature* and *Science* Editorials

Mike Hulme<sup>1\*</sup>, Noam Obermeister<sup>2</sup>, Samuel Randalls<sup>3</sup>, Maud Borie<sup>4</sup>

<sup>1</sup> Department of Geography, Downing Place, University of Cambridge,  
Cambridge CB2 3EN [\* Corresponding author]

<sup>2</sup> Independent Researcher, London, UK

<sup>3</sup> Department of Geography, University College London, Gower Street, London WC1E 6BT

<sup>4</sup> Department of Geography, King's College London, Strand, London WC2R 2LS

### Abstract

Through their editorialising practices, leading international science journals such as *Nature* and *Science* interpret the changing roles of science in society and exert considerable influence on scientific priorities and practices. Here we examine nearly 500 editorials published in these two journals between 1966 and 2016 which deal with climate change, thereby constructing a lens through which to view the changing engagement of science and scientists with the issue. A systematic longitudinal frame analysis reveals broad similarities between *Nature* and *Science* in the waxing and waning of editorialising attention given to the topic. But although both journals have diversified how they frame the challenges of climate change, they have done so in different ways. We attribute these differences to three influences: the different political and epistemic cultures into which they publish; their different institutional histories; and their different editors and editorial authorship practices.

There are many ways of mapping and analysing discourses of climate change over time. Earlier studies have followed print and broadcast media<sup>1,2</sup>, publishing trends in scientific journals<sup>3</sup>, political speeches<sup>4</sup> and international negotiations<sup>5</sup>, evolving linguistic<sup>6</sup> and visual vocabularies<sup>7</sup>, public perceptions of climate risk<sup>8</sup>, social dramas<sup>9</sup> and careers of individual scientists<sup>10,11</sup>. However, the editorial content of leading science journals may also reveal the changing nature of the challenge climate change presents to science and society alike.

Given their status as prestigious multi-disciplinary scientific journals<sup>12</sup>, *Nature* and *Science* are routinely read not just by scientists, but also by academics more widely and by science-policy analysts, science journalists and policy advisors. For example, the science pages of influential newspapers such as *Le Monde*, *The Times* (of London) and *The New York Times* frequently refer to new research published in these two journals. *Nature* also lends its support to a media centre to brief journalists and civil servants about breaking science stories<sup>13</sup> and the professional body which publishes *Science* (the American Association for the Advancement of Science; AAAS) recently launched an equivalent service (SciLine) in the United States<sup>14</sup>. *Nature* and *Science* therefore act as key sites for the production, interpretation and circulation of knowledge in scientific, academic and influential policy and media networks. Although processes for validating scientific knowledge continue to change, peer-review remains one of the chief means through which knowledge is assessed, validated and rendered authoritative<sup>15,16</sup>. Peer-reviewed journals therefore actively contribute to the creation of what is accepted as reliable and authoritative knowledge<sup>17</sup>. *Nature* and *Science* should be thought of alongside laboratories, observatories, field sites, conferences and assessment processes as influential spaces where knowledge is not merely communicated, but actively constructed and authorised<sup>18,19,20</sup>. In this sense, leading science journals become essential nodes for communication not just between scientists, but also between science and other social worlds.

One central feature of weekly journals such as *Nature* and *Science* is the editorial. An editorial is a short article that expresses either the editor's or an invited author's opinion on a topical subject of particular interest to the journal's readership. Editorials have been present in both journals since their founding (*Nature* in 1869; *Science* in 1880) and became regular top-line weekly items in *Nature* from the 1920s and in *Science* from the early 1950s. Baldwin's history of the journal *Nature* notes the importance of the *Nature* editorial and

observes how “editorial styles might affect the reception and reputation of the journal”<sup>21</sup>. Editorials are distinct from other science journal content in being opinionated commentaries and they are understood to be such by their readers. They are typically written in an informal or provocative manner, interpreting current scientific events and controversies, setting out agendas, engaging in advocacy and passing judgement on matters of concern and political dispute. Editorials can therefore reveal some of the value-laden dimensions of science, sometimes quite explicitly, and also, perhaps less visibly, the influence of political and epistemic cultures on scientific practice<sup>22</sup>. In widely-read journals like *Nature* and *Science*, editors or invited editorial authors have a platform to signal to elite audiences--both inside and outside science--what they believe should be the scientific and political priorities of the scientific enterprise. Editorials in *Nature* and *Science* have individual DOIs and are cited as sources in academic articles<sup>23</sup> (see Supplementary Note 1 & Table 1).

Editorials therefore exert influence; in other words, they are ‘performative’<sup>24,25</sup>. The backlash against *Nature’s* editorial in September 2017 on commemorative statues of deceased scientists illustrates the point. *Nature’s* editor, Philip Campbell, was forced to apologise for failing “to rise to our standards of argument and editorial treatment”<sup>26</sup> and undertook to review the journal’s internal editorial practices. This potential to influence professional scientists and wider public discourse makes the content of editorials in high profile journals especially interesting to study<sup>27</sup>. There have been a few studies analysing editorials in medical journals. For example, Hoey and Todkill (Ref. 28) commented on the politics and ethics of editorials in the *Canadian Medical Association Journal*, while Smart et al. (Ref. 29) analysed how editorials in biomedical science journals sought to standardise classifications of race and ethnicity. With specific regard to *Nature* and *Science* editorials, only Waaijer and colleagues have conducted systematic study. In a bibliometric analysis of *Nature’s* and *Science’s* editorials during the decade 2000-2009, Waaijer et al.<sup>23</sup> hint at both similarities and differences in editorial content between these two journals. A later study analysed these same journals’ editorials with respect to their positioning on the challenges of pursuing careers in science<sup>30</sup>.

In the present study we systematically analyse how *Nature* and *Science* have editorialised about climate change over the last 50 years. In particular, we ask two questions. What attention and framing patterns with regards to climate change can be

detected in editorial content and can these patterns be related to wider political or scientific events? In what ways, if any, do *Nature* and *Science* editorialise differently about climate change and how might these differences be explained? Answers to these questions are important since they will shed light on how science’s editors represent climate change to their audiences and the extent to which these two leading science journals speak with one voice on this important public and global issue. This study breaks new ground both conceptually – through a systematic longitudinal interpretative analysis of science journal editorials – and topically through its focus on the content of climate change editorials.

### About *Nature* and *Science*

Although *Nature* and *Science* are both high-impact science journals that editorialise on a weekly basis, the origins, institutional history and editorial practices of these two journals are very different (Table 1). Of particular note is that *Nature* is an independent journal published by the Nature Publishing Group, since 2015 the academic publishing division of the international conglomerate Springer-Nature. In contrast, *Science* is the weekly flagship journal of the non-profit professional body of American scientists, the AAAS. This explains the larger number of subscribers for *Science* than for *Nature* (c.130,000 cf. c.55,000, even though readership of *Nature* is likely larger than that of *Science* (Table 1). Headquartered in London, Nature Publishing Group has several offices worldwide, whereas *Science* is based in Washington DC, with just one subsidiary office in Cambridge, UK.

Table 1: Main attributes of the journals *Science* and *Nature*. Sources: Ref 21 (pp.175,188, 224); Ref 31.

	<i>Nature</i>	<i>Science</i>
<b>Creation of the journal</b>	1869. Independent weekly journal, now published by Springer-Nature.	1880. Weekly journal of the American Association for the Advancement of Science.
<b>Location of headquarters</b>	Multi-sited. Nature Research is a global company with offices worldwide, but management and principal publishing offices are in London, New York and Tokyo.	Main HQ in Washington DC, with a European office in Cambridge.

<b>2017 subscriptions</b>	Paid = 30,628 Total = 53,270 (47% in USA)	Paid = 114,126 Total = 129,564 (84% in USA)
<b>Journal Impact Factors</b>	2011 CiteScore = 14.0 2016 CiteScore = 13.3 (JIF=40.1)	2011 CiteScore = 12.0 2016 CiteScore = 14.4 (JIF=37.2)
<b>Editors in our study period</b>	John Maddox 1966-1973 David Davies 1973-1980 John Maddox 1980-1995 Philip Campbell 1995-present	Phil Abelson 1962-1984 Daniel Koshland 1984-1995 Floyd Bloom 1995-2000 Donald Kennedy 2000-2008 Bruce Alberts 2008-2013 Marcia McNutt 2013-2016 Jeremy Berg 2016-present
<b>Published editorials in our period (1966-2016)</b>	c.6000	c.2650
<b>Editorials in our final corpus</b>	N=333 (c.5.6%)	N=160 (c.6%)
<b>Editorial authorship</b>	Always anonymous; predominantly authored by the editor	Attributed; frequently invited authors

During the period of our study *Nature* had just three editors (Maddox served two terms) and *Science* a total of seven (Table 1). John Maddox and Phil Abelson were the respective chief editors for the two journals during the earlier decades of our period and both editors were very influential in ‘modernising’ their respective journals<sup>32,21</sup>. During the 1970s and 1980s they professionalised editing processes and sought to position their journals within the burgeoning international and increasingly mobile community of scientists. *Nature’s* editorials have always been published anonymously, although usually written by the journal’s chief editor<sup>21</sup>, in contrast to *Science* which has always operated a practice of named authors, frequently inviting external guests to editorialise (see Supplementary Table 2). For example, President Clinton (June 1997) wrote about the promise of science in the twenty-first century and President Obama (January 2017) about clean energy. During the period of our study *Science* has published just a single editorial each week, whereas *Nature* has varied between one and three editorials weekly, with three latterly becoming the norm.

### Editorial challenge and attribute frames

We extracted a relevant corpus of climate change editorials for the period 1966-2016 using search terms ‘climate’, ‘greenhouse’, ‘carbon’, ‘warming’, ‘weather’, ‘atmosphere’ and ‘pollution’ as an initial filter and subjected it to frame analysis (see Methods). The final corpus consisted of 493 editorials, 333 for *Nature* and 160 for *Science*, representing for both journals between 5% and 6% of all editorials published during this period. Our frame-set distinguished between eight different ‘challenges’ and three different ‘attributes’ (see Table 2). Each of the 493 editorials was allocated a single primary frame (i.e., the dominant ‘challenge’ of climate change) and, if appropriate, any number of additional ‘other’ challenges selected from the frame-set. ‘Attributes’ for each editorial were coded as a simple binary—presence or absence—as appropriate. Inter-coder reliability improved through two pilot exercises and collaborative coding (see Methods).

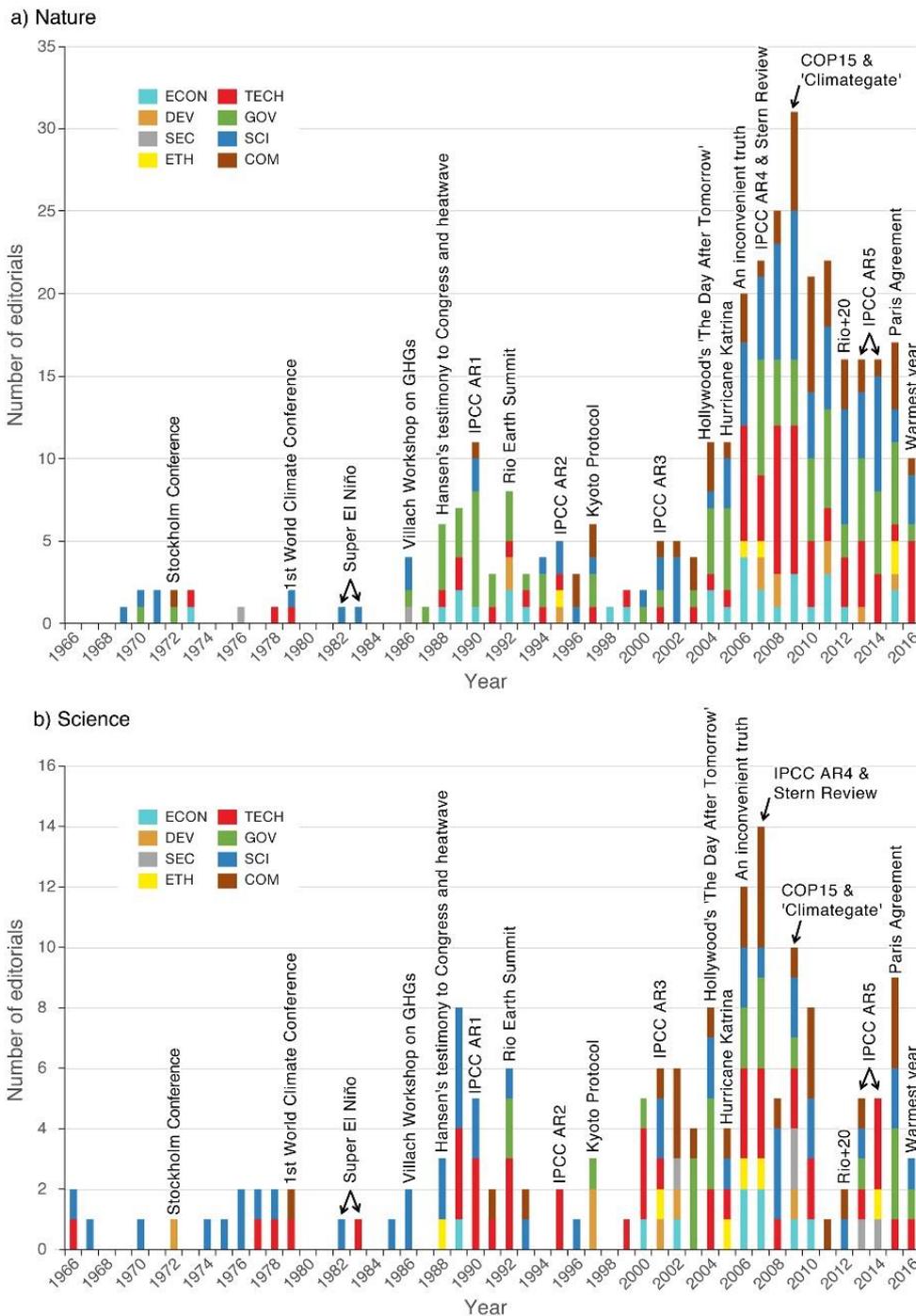
Table 2: Final frame-set used in coding the editorials.

	<b>CHALLENGES</b>
<b>ECON = Economic/financial challenge</b>	<i>Climate change is an externality of economic growth and/or certain modes of production/consumption and/or requires improved quantification of costs/benefits of impacts and/or policies and/or can/should be tackled through economic &amp; financial instruments</i>
<b>DEV = Developmental challenge</b>	<i>Climate change is a by-product of pathways and patterns of socio-economic development and/or unequal development inhibits adequate mitigation, resilience and adaptation and/or causes uneven distribution of harms to human health, well-being and perceived human security</i>
<b>SEC = National/international security challenge</b>	<i>Climate change is a geopolitical security risk by introducing new dangers into inter- and intra-state relations and/or is a threat-multiplier requiring new forms of international or state-level security responses</i>
<b>ETH = Ethical/Moral challenge</b>	<i>Climate change raises important questions of procedural and/or distributive justice (e.g. burden-sharing) and/or people have an ethical responsibility/moral duty towards future humanity and/or nature and/or the ‘poor’/the most vulnerable and/or God/deities, to mitigate climate change</i>
<b>TECH = Technological/ Energy challenge</b>	<i>Fossil-fuel based energy technologies are the root cause of climate change and/or technological innovation and energy transitions that aim at reducing/capturing/sequestering GHG emissions and/or solar engineering technologies are essential to tackle climate change.</i>
<b>GOV = Institutional/ governance challenge</b>	<i>Structural and institutional inertia/problems are a root cause of climate change and/or tackling climate change requires new/improved governance institutions</i>

	<i>and/or regulatory management of adaptation/mitigation policies is inadequate [not to be used if this governance challenge is covered by a more specific frame]</i>
<b>SCI = Scientific challenge</b>	<i>Scientific understanding of climate change is incomplete/inadequate (i.e., due to complexity/uncertainty) and/or investing in science is necessary for adequate mitigation/adaptation responses</i>
<b>COM = Communication challenge</b>	<i>Climate science and climate risks is/are poorly communicated to <u>public</u> audiences and/or media representations of climate change are problematic/biased and/or deliberate misinformation/manufactured scepticism confuses political/public opinion</i>
	<b>ATTRIBUTES</b>
<b>Global/ Collective scale</b>	<i>The editorial draws attention to the global/collective/cooperative/supra-national scales of the stated response(s) to the designated challenge(s)</i>
<b>Urgency</b>	<i>The editorial draws attention to the temporal/political urgency with which the designated challenge(s) should be addressed</i>
<b>Policy</b>	<i>The editorial draws attention to specific policy instruments and/or measures which are being implemented/or should be implemented in order to respond to the designated challenge(s)</i>

Both journals show broadly similar frequency patterns in their climate change editorialising (Figure 1). During the first two decades very few editorials addressed climate change as an issue and, of those that did, several were written to resist or downplay environmentalist claims. For example in 1970, Fred Singer—as Chair of the Committee on Environmental Quality at the AGU—wrote a guest editorial for *Science* about the danger of ‘exaggerated claims’<sup>33</sup>, whilst the following year *Nature’s* editor, John Maddox, wrote an editorial about ‘the great greenhouse scare’<sup>34</sup>. Until the mid-1980s many of the issues of the day—atmospheric pollution, energy security, poverty, development, internationalisation of science—were editorialised in both journals with little, if any, consideration of climate or climate change. However, the late 1980s saw the well-established emergence of climate change as a salient public policy issue in the USA and western Europe<sup>35</sup> and this is clearly reflected in these journals’ editorialising. 1988 was the first year in which more than two ‘climate change editorials’ (according to our definition) were published in both journals. The later, more global, prominence given to climate change in public arenas from the mid-2000s through to 2010<sup>1</sup> is also clearly reflected in editorial attention. Indeed, for every year since 2004 *Nature* has published at least 10 ‘climate change editorials’. *Science’s*

editorialising about climate change peaked in 2007 (n=14; more than 25% of all editorials that year), *Nature's* in 2009 (n=31; around 20% of all editorials) and while the decline in editorial attention after COP15 at Copenhagen is evident in both journals, the decline was more pronounced in *Science* (notably in 2011 and 2012).



*Figure 1. Primary challenge frames. The frequency of primary challenge frames by year in A) Nature's climate change editorials (n = 333) and B) Science's climate change editorials (n = 160). Some key scientific, political, cultural and meteorological events (cf. Ref 1) relating to climate change are overlain on each graph. ECON = economic/financial, DEV = developmental, SEC = national/international security, ETH = ethical/moral, TECH = technological, GOV = institutional/governance, SCI = scientific, COM = communication (see Table 2 for full frame code definitions).*

These peaks and troughs, evidenced similarly in both journals, closely track patterns of attention to climate change found in popular media<sup>1</sup>. These patterns are partly driven by key scientific, political, cultural and meteorological events concerning climate change (Figure 1), but also reflect the competition dynamics between different 'social problems' seeking access to scarce media resources available in public arenas<sup>36</sup>. As leading scientific journals, perhaps of greatest interest for *Nature* and *Science* were the five major assessment reports of the Intergovernmental Panel on Climate Change (IPCC) published in 1990, 1996, 2001, 2007 and 2013/14.

### **Editorial framings by era**

To better reveal the changing patterns in editorial framings we periodised the data according to these publication dates, thus generating six eras: the pre-IPCC era (pre-1988) and then five 'IPCC eras', each of which commences two years prior to publication and ends two (or three) years after (Figure 2). There has been a diversification over time in how climate change has been framed. In the earlier three eras, both journals primarily framed climate change as a scientific, energy/technology or institutional/governance challenge; 78% of all editorials prior to 1999 had their primary frame as one of these three categories. In the later three eras—'AR3', 'AR4' and 'AR5'—this fell to 67%.

This frame diversification was much more pronounced for *Science* (85% down to 58%) than for *Nature* (73% to 71%). Especially noteworthy was the increase in framings of climate change as a communication challenge (e.g Ref <sup>37</sup>), up from 7% of all editorials prior to the 'AR3-era' to 18% since then. This move is again more noticeable for *Science* (6% to 22%) than for *Nature* (8% to 16%). In the 'AR5-era', the communication challenge as a

primary frame is almost on a par with those of science, energy/technology and institutions/governance (Figure 3). Two other points are noteworthy. Climate change as an economic/financial challenge (e.g. Ref<sup>38</sup>) was most prevalent for both journals in the ‘AR4-era’ (2005-2010), coinciding with the publication of the Stern Review on the economics of climate change in 2007<sup>39</sup>. And the identification of climate change as an ethical/moral challenge (e.g. Ref<sup>40</sup>) has been notable only since 2005. Since then, 6.5% of all editorials have adopted this challenge as their primary frame and a further 5.5% as an additional frame (Figure 2).

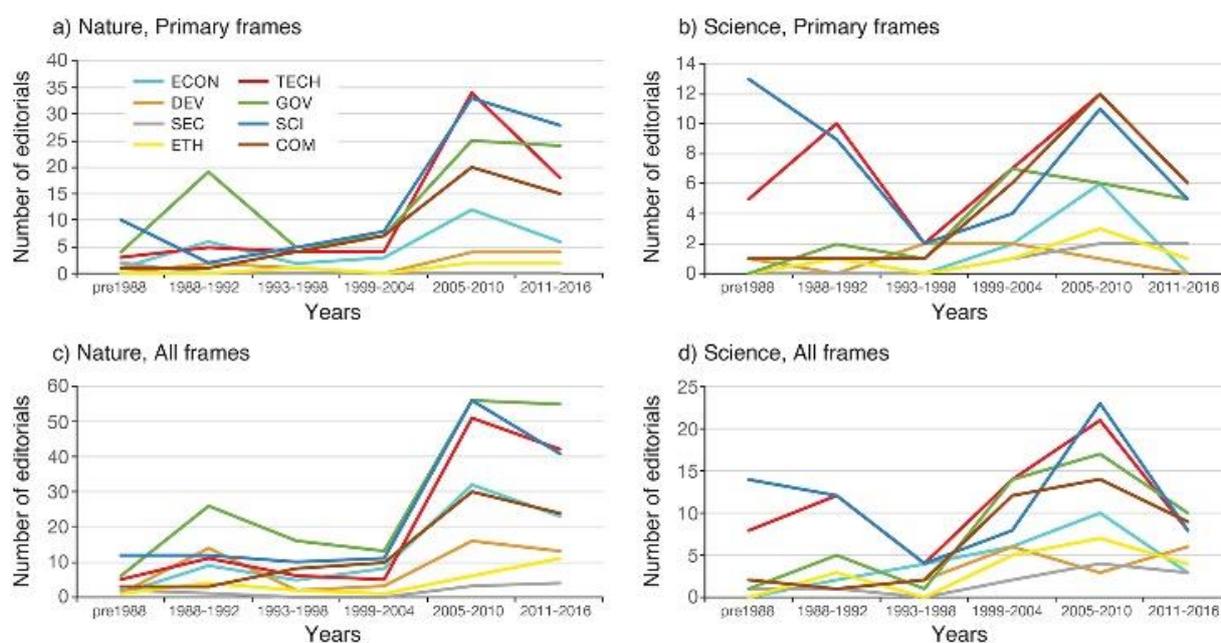


Figure 2: Challenge frames by IPCC era. The absolute frequencies of primary frames (A) and (B) and all frames (C) and (D) in Nature (A) and (C) and in Science (B) and (D) editorials for each IPCC era. ECON = economic/financial, DEV = developmental, SEC = national/international security, ETH = ethical/moral, TECH = technological, GOV = institutional/governance, SCI = scientific, COM = communication (see Table 2 for full frame code definitions).

Despite these broad similarities, there are some important differences in how these two journals editorialise about climate change. This is evident, for example, from the first attention peak during the ‘AR1-era’, 1988-1992. For *Nature*’s editorials in this period,

climate change was primarily an institutional/governance challenge, whereas for *Science* it was largely either a technology/energy (42% of all editorials framed thus) or a scientific challenge (38%). In contrast to 54% of *Nature's* editorials during 1988-1992 framing climate change as an institutional/governance challenge, only 8% of *Science's* editorials did so. *Nature* only began to give significant emphasis to the technology/energy challenges of climate change from the 'AR4-era' onwards, while *Science* only began seriously to emphasise the institutional/governance challenge from the 'AR3-era' onwards (Figure 2). Over the whole period of the study, *Nature* emphasises the institutional/governance challenges of climate change much more than does *Science*: 51% of its editorials have this as at least one of its multiple frames, compared to only 30% for *Science*.

There are also significant differences in the attributes attached to the two journals' editorials. Although both journals frequently frame climate change as a 'global' challenge, *Science* has increasingly emphasised this attribute over time, more than doubling from 'AR1-era' to 'AR5-era' its percentage of editorials so framed (Figure 3). *Science* has also framed climate change more frequently as 'urgent', noticeably during the most recent 'AR5-era'. Conversely, *Nature* has been much more willing to comment on policy instruments and measures (27% of editorials with the 'policy' attribute) than has *Science* (17%). In summary, while both journals frequently, and in broadly equal proportion (26% and 27%), primarily frame climate change as a scientific challenge (e.g. Ref <sup>41</sup>), as might be expected, *Nature* pays more attention to the institutional/governance aspects of the challenge and is more engaged in discussing specific policy instruments, including economic/financial challenges. In contrast, *Science* emphasises the technology/energy challenges of climate change and, especially latterly, the communication challenge.

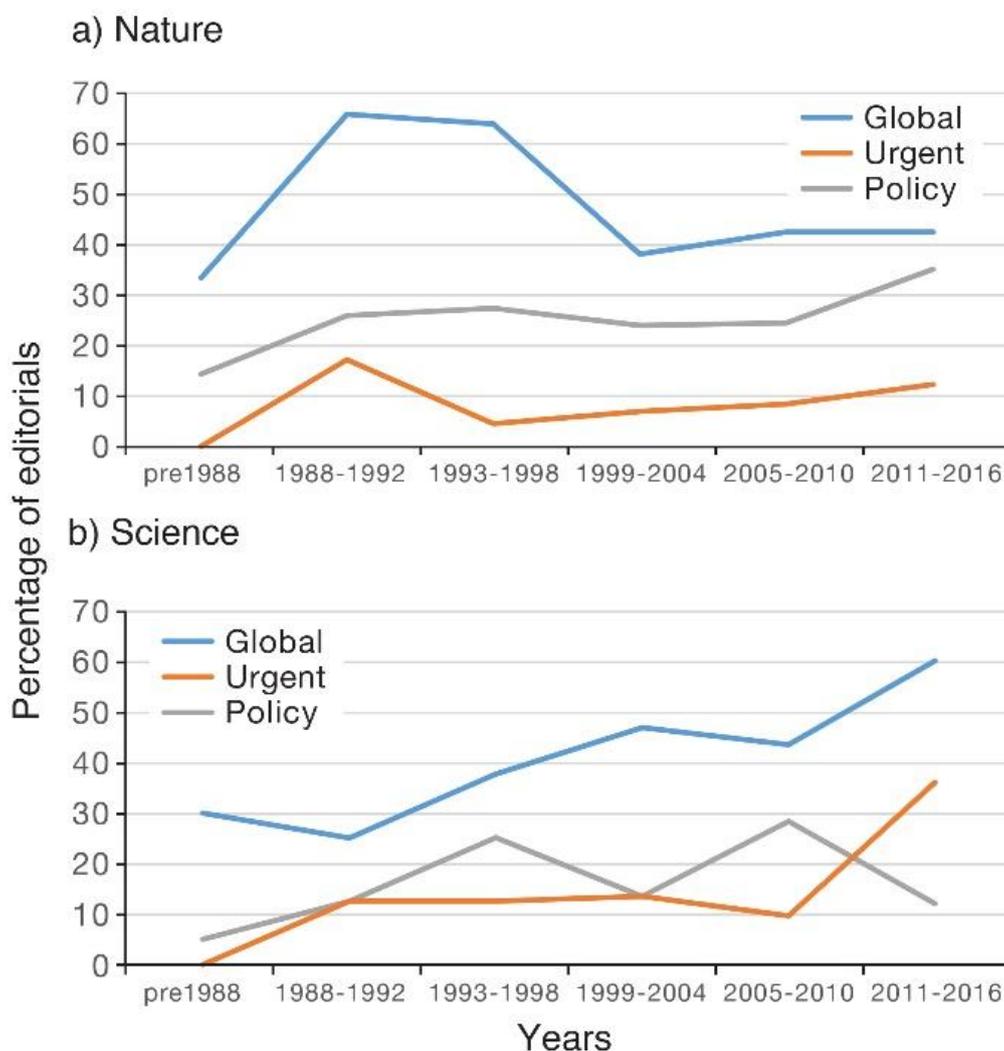


Figure 3: Attribute frames by IPCC era. The percentage of editorials in each 'IPCC-era' displaying specified 'attributes' for: A) Nature (top); and B) Science (bottom). For 'attribute' definitions refer to Table 2.

## Discussion

Although both journals have greatly increased their editorial attention to climate change in recent decades, this attention has been episodic--notably peaking around 1990, in the years leading up to 2009 and then again in 2015. These peaks are partly related to external events in the worlds of science (e.g. IPCC reports), politics (e.g. the Copenhagen Summit, the Paris Agreement), public culture (e.g. films such as *An Inconvenient Truth*; controversies such as Climategate) and meteorological events (e.g. the American drought of 1988). These attention patterns broadly follow those found elsewhere in popular media outlets, especially newspapers<sup>1,35</sup>. This suggests that *Nature's* and *Science's* editorial decision-

making partly reflects the mainstream media's framing of social problems. The editorials also reveal how over time climate change has become a sufficiently familiar 'matter of concern' that it increasingly is used to illustrate wider issues which occupy editorial attention; for example the relationship between science and development, the challenges of science communication, the internal organisation of science, science funding, and so on. This partly explains the diversification of frames noted above, especially notable in the case of *Science* (but here more diverse authorship is important; see below).

Yet our results also reveal some significant differences in framings between the two journals. *Nature* has consistently emphasised the international institutional/governance challenges of climate change to a much greater extent than has *Science* and has remained more willing to comment directly on policy instruments and measures (e.g. Ref. <sup>42</sup>). In contrast, for a long time *Science* framed climate change predominantly in terms of either scientific or energy/technology challenges and yet in recent years has widened its framings considerably. It has retained a more sustained emphasis on the public communication challenges of climate change than has *Nature*, increasingly framing climate change as global and urgent (e.g. Ref. <sup>43,44</sup>), whilst at the same time retreating in recent years from commenting directly on specific policy instruments and measures.

We suggest that the different political cultures in which these journals operate, and their different institutional histories, may partly explain these differences. *Science's* editorialising is influenced by the polarised cultural politics of climate change found in the United States and by certain conceptions of the role and legitimisation of science in society. These 'local influences' on *Science* are reinforced by the journal's role as the 'house magazine' for the professional association of American scientists, which is the primary audience for its editorials. In contrast, *Nature* has no comparable institutional audience and yet it too operates within a distinctive political and epistemic culture. Its editorialising about climate change seems to reflect a more cosmopolitan perspective on science in general<sup>21</sup> and a more internationalist perspective on climate change in particular. This latter position is shaped by the distinct British/European self-perception of its 'climate change leadership'<sup>45</sup> extending back to the late 1980s. Although both journals report developments in international science and publish new science from all around the world, in this sense seemingly offering on climate change a 'view from nowhere'<sup>46</sup>, neither journals'

editorialising escapes the pull of their respective operating cultures. The differences in climate change framings found in these scientific journals have some similarities with those found in comparative trans-Atlantic studies of newspaper framings of climate change. US media frame climate change more as a scientific puzzle to be understood, compared to UK media which engage more directly with solutions and policies<sup>47</sup>.

Yet differences in political cultures is only part of the explanation for differences between *Nature* and *Science*. Also significant are the personalities, priorities and practices of the specific editors who commission or author individual editorials and the differences in the author profiles between the two journals. *Nature's* editorials are always unsigned, leaving it ambiguous as to the specific authorial voices being expressed in each case. We know that *Nature's* editor is "ultimately accountable for *Nature's* content"<sup>26</sup> and yet the cloak of anonymity is rarely if ever removed. On the other hand, *Nature* editor John Maddox's provocative stance with regards to environmentalism in the 1970s<sup>21</sup> undoubtedly influenced some of this journal's early editorial content on climate change<sup>32</sup> and Campbell's tenure as editor since 1995 means that he has commissioned (if not written) 80% of *Nature's* climate change editorials. Campbell, an astrophysicist who first started working for *Nature* in 1979, has therefore exerted significant personal influence in developing *Nature's* editorial stance on climate change over the last 25 years.

*Science's* practice of attributed editorials is in sharp contrast to *Nature* and means that it is possible to analyse authorship patterns and profiles (see Supplementary Information Note 2). Whilst around 57% of editorials have been authored directly by editors or other AAAS staff, this still leaves a significant diversity of voices speaking for science through the editorials of *Science*. Only 16% of these authors had affiliations *outside* the USA. The influence exerted by specific editors at *Science* can also be traced, whether it be Abelson's focus on 'energy/technology' and 'science' challenges, the significant attention Kennedy gave since 2000 to climate change's 'communication' and 'institutional/governance' challenges, or McNutt's very deliberate foregrounding between 2013 and 2016 of female authorship (see Supplementary Information Table 2). Inviting guest editorials is a practice that has become *more* common at *Science*, as too has co-authorship, and likely contributes to explanations of why its editorial framings of climate change have diversified more than have *Nature's* (Figure 2). That *Science's* editorials are

always attributed is also significant with regards to their subsequent visibility. Although both journals' editorials have similar salience in terms of altmetric scores, *Science's* editorials are much more likely to be formally cited in academic literature (Supplementary Note 1), probably because attribution allows them to be traced more easily and unambiguously.

There are a number of limitations to this study. As with all framing analysis, unambiguous and fully objective frames are not attainable, although our careful iterative construction of the frame-set and our separation of 'challenges' from 'attributes', and of 'primary' from 'other' frames, affords a robust interpretative framework for analysis (see Methods). We have not been able to study at first-hand, either through ethnography or interviews, the editorial decision-making processes that operate within these two journals. Such approaches might offer further insights into the boundary-ordering work<sup>48</sup> performed by these editorials. And there have also been significant changes during the study period in scientific publishing culture and audience reach and attention which we have not analysed.

Our study offers a first sight of how editorialising attention and framing works in the case of climate change for *Nature* and *Science*. We suggest that scientific journal editorials could be studied more closely for revealing some of the ways in which science and society shape each other. They reveal some of the tensions between global kinds of knowledge brought forward by science and the local meanings of such universal knowledge when inserted into specific political cultures<sup>49</sup>. Editorials in science journals make important interventions across the boundaries of science, society, ethics and politics, whereby science stakes both its claim to epistemic authority *and* its relevance for policy-making. Yet these claims never entirely escape the centripetal pull exerted by the journals' institutional histories and political geographies. As geographers of science have frequently shown, 'place' matters in the making and interpreting of scientific knowledge<sup>15,50,51</sup>. But this study has also shown that the profile and priorities of individual editors matters for the way in which, through their editorialising, these two leading science journals give shape and meaning to a challenge like climate change. Science never can nor ever does speak for itself, not least unto the worlds of climate politics and public policy. Understanding science's editorial filters, as exemplified here in the case of *Nature* and *Science*, also shows that science's editors never speak with one voice.

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Correspondence and request for materials should be sent to M Hulme <mh903@cam.ac.uk>

### Author Contributions

M.H. initiated and designed the study and led on writing; N.O. and M.H. extracted the corpus; M.H., N.O., S.R. and M.B. all contributed to coding, analysis, interpretation and improvements to the text; N.O. and S.R. contributed statistical analysis and graphics; M.B. conducted a literature review, analysed citation and altmetric scores, and extracted author details of *Science* editorials.

### Competing Interests

The authors declare no competing financial interests.

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## Methods

*Establishing the Preliminary Corpus.* One of the co-authors followed a strict protocol in which they went through every single issue of both journals from 1966 to 2016 and, using a generous criteria of relevance, opened all editorials which could conceivably be related to climate change. Once in the document, they performed an initial keyword search to identify one or more of the following words: 'climate', 'greenhouse', 'carbon', 'warming', 'weather', 'atmosphere', 'pollution'. (Keyword searches for *Nature* editorials prior to 1998 were not possible since the digital copies of these editorials were scans of the print versions; these editorials were read in their entirety). If one of these keywords was present the editorial was then read carefully to make a determination as to whether it could potentially be relevant for the study. Editorials were then saved in either a 'certain' or a 'maybe' folder. A triangulation was then performed against a 'corpus of opportunity' which the lead author had maintained in real-time since 2003 (and back-dated to 1966) using a more subjective judgement of climate change relevance. This triangulation between two independent methods yielded a preliminary corpus with  $n = 428$  for *Nature* and  $n = 180$  for *Science*, accounting for between 6 and 7% of all editorials published by either journal. A further check on the corpus identification was enabled through comparison with Waaijer et al.<sup>21</sup> (see below).

*Identifying Frames and Attributes.* We adopted frame theory and analysis<sup>49</sup> in order to scrutinise systematically the ways in which *Nature's* and *Science's* editorials described and communicated climate change to their readerships. Frame analysis is a discourse analysis method, suitable for dissecting how an issue is defined and problematized. 'Frames' are interpretative storylines, created by authors and communicators, that help identify what is at stake in an issue; a frame reveals what an author feels is important about an issue. For this reason framing is never 'ideologically neutral'. Frame analysis therefore offers a rich way to explore how different actors (in our case, editorial authors) define an issue in strategic ways, offering common points of reference and meaning between author and reader<sup>50</sup>. Frames strongly hint at an assumed 'problem-solution formation'<sup>49</sup>. For instance, if climate change is presented principally as a technology/energy challenge, addressing climate change then becomes primarily a matter of mitigating emissions through energy

systems transitions and innovation, rather than through attending to considerations about, for example, justice, governance, adaptation or resilience.

For the purpose of this research we constructed eight 'issue-specific' frames (i.e., specific to the issue of climate change as engaged by *Nature* and *Science*) through a mixed inductive-deductive approach<sup>50,51</sup>. Before the coding commenced we formulated, deductively, eight candidate frames (and their definitions) drawing upon four frame criteria<sup>52</sup>: identifiable conceptual and linguistic features; commonly observed; easily distinguished from other frames; recognisable by others. The frames and definitions were then refined, iteratively, during the two pilot phases (see below) as we inductively sought to apply the above four criteria. Working collaboratively together through small samples of the corpus helped the four authors identify areas where frames either overlapped or where they lacked clarity of definition.

This led us to make various changes to our initial (deductive) frame-set. First, we conceived of our frames as 'challenges' to better reflect the 'problem-solution formation' evident in many of the editorials. Second, we distinguished between 'challenges' and what we called 'attributes': i.e., 'global', 'urgent', 'policy' (see Table 1). These were attributes of the challenge rather than a distinct frame of their own and their presence or not in an editorial was identified using a binary classification. Third, following from the above considerations, we adjusted our frame-set by re-classifying one frame ('policy challenge') as an attribute and adding a new eighth challenge ('moral/ethical'). Finally, we decided to distinguish between the one 'primary' (i.e., dominant) frame (challenge) of an editorial and any number of 'other frames'.

*Pilot Coding.* For the purpose of testing and refining the frame-set and the coding framework two pilot exercises were conducted. For each pilot, 15 editorials were extracted at random from each journal giving a pilot set of 30 editorials. All four authors then coded independently using a simple binary system (0 or 1) for presence/absence of each frame and attribute. After the first pilot, the authors deliberated collectively on how to modify the frame-set and frame captions (see above). The re-adjusted (and final) coding scheme was then re-tested in the second pilot. Following this second pilot the authors resolved any remaining ambiguities in the frame captions and agreed on how to proceed with coding the

whole corpus (see below). Fleiss kappa scores (kappa scores adjusted for use with multiple coders rather than just two<sup>53</sup>), were used to measure inter-coder reliability between the four coders (authors) in each of the two pilots (see Supplementary Table 5). Reliability scores increased between the two pilots, although remained only moderate-to-fair. For this reason each author used an agreed colour code to flag editorials in the full corpus which they deemed particularly difficult to code and these were resolved through group deliberation (see below). Coding ‘attributes’ was considerably more reliable than coding ‘challenges’ and kappa scores here revealed substantial agreement.

*Coding the Corpus.* For the coding of the full preliminary corpus, each of the 608 editorials was randomly allocated to one of the four authors. Each author had common instructions to highlight in red the editorials they judged should definitely be removed from the corpus, in orange the editorials that might be considered ‘out of scope’ and where a collective determination should be made, and in blue the editorials which were particularly difficult to code. In determining between the primary and ‘other’ frames of an editorial, authors interpreted the editorials in their historical context. In cases where an editorial referred to specific external documents or reports - which themselves framed climate change in particular ways - the authors coded the frames used by the author of the editorial, *not* the frames of the external source. Similarly, for editorials where climate change was mentioned as a substantive example of a wider issue the authors judged the frame in which climate change was placed, not the framing of the wider issue (which on occasions could be at odds with each other). Finally, in coding ‘other frames’, the authors erred on the side of inclusion rather than exclusion (i.e., if in doubt about the relevance of an ‘other frame’ the coders would include it).

*Confirming the Final Corpus.* The authors resolved through collective deliberation the coding decisions for all editorials which had been flagged red, orange or blue. Where the authors could not come to a consensus regarding the inclusion of particular editorials in the final corpus (less than 10 instances) the lead author made a final decision. The orange editorials that *were* included in the final corpus (28 for *Nature*; 11 for *Science*) were all coded collaboratively. All four authors also discussed and coded collaboratively each blue flag in the preliminary corpus (i.e., where frame identification was judged particularly difficult). This sub-set consisted of 29 editorials in *Nature* and 17 in *Science*. Combining

these two sub-sets meant that 85 of the more challenging editorials to code (57 in *Nature* and 28 in *Science*; around 17% of the final corpus) were coded collaboratively, thus assuaging to some degree the relatively modest kappa scores secured in the second pilot. The series of iterative processes described above were designed to reach consistent decisions regarding inclusion/exclusion of editorials in the final corpus and consistent judgements about frame codes.

The final corpus carried forward for analysis comprised 333 editorials for *Nature* (a loss of 30% of editorials compared to the preliminary corpus) and 160 editorials for *Science* (9% loss). The final corpus for the decade 2000-2009 was compared with that extracted by Waaijer et al.<sup>21</sup> These authors extracted all *Nature* and *Science* editorials and through an automated word search and subsequent cluster analysis identified those that were deemed to be concerned with 'climate change' (NB. Their study was not concerned with climate change per se). For this decade Waaijer identified 80 such editorials in *Nature* and 65 in *Science*. This compared with 136 *Nature* editorials in the final corpus used in this study (70% more than Waaijer) and 74 for *Science* (15% more). These differences reflect different methodologies—automated versus interpretative—and to the fact that the current authors read carefully each candidate editorial before reaching a decision. This study also retained editorials in which climate change was a substantive example of a wider issue or concern, whereas Waaijer's analysis was designed to allocate all editorials to just one of 15 exclusionary editorial clusters.

*Data Availability.* All the editorials analysed in this study are available through *Nature* and *Science* web-site archives. The details (date, title, volume, DOI) of the final corpus of 493 editorials designed 'climate change' are available at the public data repository FigShare, <https://doi.org/10.6084/m9.figshare.5878303.v1>.

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## Framing the Challenge of Climate Change in *Nature* and *Science* Editorials

Mike Hulme, Noam Obermeister, Samuel Randalls and Maud Borie

### Supplementary Information

*Supplementary Note 1: Analysis of citations and altmetric scores.* To gain a sense of the relative salience of climate change editorials in these two journals we analysed all editorials in our corpus for 2015 and 2016, a total of 38 editorials. In order to evaluate both academic and non-academic salience we used altmetrics, which gives an idea of how frequently editorials were shared beyond academic spheres, e.g. shared on Twitter, Pinterest, Reddit, Facebook, etc., and also Scopus, which identifies the number of citations in formal academic literature. Results are in Supplementary Table 1.

Editorials in both *Nature* and *Science* gain broadly similar on-line attention with average altmetrics scores greater than 100. This suggests that editorials in both journals are frequently shared and hence contribute to wider academic and public discussions. With regard to citations however, editorials in *Science* are cited significantly more frequently than editorials in *Nature* (on average by a factor of 9). This seems very likely due to the association of named authors with *Science* editorials. It is much easier to locate them in search engines and also easier for academic authors to situate attributed editorials in particular debates. In contrast, locating anonymous *Nature* editorials in Scopus is much more challenging and citing an anonymous commentary in specific debates less appealing.

*Supplementary Table 1: Citations (from Scopus) and altmetrics scores for Nature and Science 'climate change editorials' published in 2015 and 2016. [Census date: 22 November 2017]. The former captures formal scientific visibility, the latter the broader informal salience of the editorials.*

	Number of editorials	Total cites	Average cites	Total Altmetric score	Average score
<b><i>Nature</i></b>	26	13	0.5	3414	131
<b><i>Science</i></b>	12	55	4.6	1231	103

*Supplementary Note 2: Analysis of Science editorials' authors.* Since all *Science* editorials are attributed to named individuals we extracted information about the authors of all 160 'climate change editorials' in our corpus (Supplementary Table 2). The number of editorials published under the editorship of each editor-in-chief (EIC), as well as how many they personally authored, is shown in Supplementary Table 3. EICs did not only author editorials during their tenure. For example, Phil Abelson authored editorials until the year 2000, even though he ceased being EIC in 1984. The significance of different EICs for the framing of the climate change challenge is clear (Supplementary Table 3). For Abelson and Koshland, climate change was a 'scientific challenge' (SCI) in, respectively, 59% and 45% of editorials they commissioned and/or authored during their tenure. With Kennedy as EIC, however, it was only 13%, whereas 22% of his commissioned editorials framed climate change primarily as a 'communication challenge' (COM).

*Supplementary Table 2: Author details of all 'climate change editorials' in our corpus published in Science (n=160).*

Year	EIC	Name	Country	Location	Role	Gender
2016	Jeremy Berg	Sir David King	UK		UK Foreign Secretary's Special Representative for Climate Change	M
2016		Patricia Espinosa	Germany		Executive Secretary of UNFCCC	F
2016		Johan Rockström	Sweden	Stockholm	Academic/Chair of the Earth League	M
2015	Marcia McNutt	Marcia McNutt	US	DC	Editor in Chief	F
2015		Alan I. Leshner	US	DC	Chief Executive Officer or AAAS and Publisher of Science	M
2015		Marcia McNutt	US	DC	Editor in Chief	F
2015		Marcia McNutt	US	DC	Editor in Chief	F
2015		Marcia McNutt	US	DC	Editor in Chief	F
2015		Marcia McNutt	US	DC	Editor in Chief	F
2015		Diana H. Wall	US	Colorado	Academic/Science, Soils Institute	F
2015		Fran Ulmer	US		Chair of US Arctic Research Commission	F
2015		Hoesung Lee	Switzerland		Chair of the Intergovernmental Panel on Climate Change	M
2014		Marcia McNutt	US	DC	Editor in Chief	F
2014		Marcia McNutt	US	DC	Editor in Chief	F
2014		David Titley	US		Academic/Retired Admiral	M
2014		Kirk R. Smith	US	California	Professor/Global environmental health	M
2014		Sally M. Benson	US	Stanford	Director of the Precourt Institute for Energy and the Global Climate and Energy Project/Academic	F
2013		Marcia McNutt	US	DC	Editor in Chief	F
2013	Marcia McNutt	US	DC	Editor in Chief	F	

2013		Martin Rees	UK	Cambridge	Member of House of Lords/Astronomer royal	M
2013		Bassam Z. Shakhashiri	US	Wisconsin	Professor/Chemistry	M
2013		Susan. Haig , Thomas Martin , Charles van Riper, T. Douglas Beard Jr.	US		Ecologists	F M M M
2012	Bruce Albert	Alan I. Leshner	US	DC	Chief executive officer of AAAS/Publisher of Science	M
2012		Máire Geoghegan-Quinn	EU		European Commissioner for Research, Innovation and Science	F
2011		William L. Chameides	US	Durham	Dean of the Nicholas School of the Environment	M
2010		Donald Kennedy	US	DC	Editor Emeritus of Science	M
2010		Bruce Alberts	US	DC	Editor in chief of Science	M
2010		Bruce Alberts	US	DC	Editor in chief of Science	M
2010		Brooks Hanson	US	DC	Deputy Editor for Physical Sciences in Science	M
2010		Ralph Cicerone	US		President of US Academy of Science	M
2010		Anette Schaven	Germany		Minister of the Federal Ministry of Education and Research	F
2010		John Church	Australia		CSIRO (Research Centre)	M
2010		William H. Schlesinger	US	Milibrook	President of the Cary Institute of Ecosystem Studies	M
2009		Eric J. Barron	US	Colorado	Director of the NCAR	M
2009		Steven Chu	US		US. Secretary of Energy/Nobel Laureate in physics.	M
2009		Rosina M. Bierbaum and Robert B. Zoellick	US		Academic (University of Michigan)/ Co-Director of the World Development Report; President of World Development Bank	F M
2009		Walter V. Reid, Catherine Bréchnignac, Yuan Tseh Lee	US, France, Taipei		ICSU	M F M
2009		Paul Falkowski and Robert Goodman	US	Rutgers	Rutgers Energy Institute	M
2009		M. S. Swaminatha	India	Chennai	UNESCO Chair of ecotechnology	M
2009		Albert Grimaldi	Monaco	Monaco	Prince of Monaco	M
2009		Glenn Schweitzer	US	DC	Director of Eurasian Programs at the U.S.National Academy	M
2009		Sir David King	UK	Oxford	Director of the Smith School of Enterprise and the Environment,	M
2009	Leon M. Lederman and Shirley M. Malcom	US		Academic/AAAS	M F	
2008	Jim Wells and Mary Woolley	US	Alexandria and San Francisco	Mary Woolley is president and chief executive officer of Research America. Jim Wells is an academic	M F	
2008	Raman Sukumar	India	Bangalore	Professor of ecology at the Indian Institute of Science	M	
2008	James Tiedje and Timothy Donohue	US		Professors of microbiology and bacteriology	M M	
2008	Susan Solomon and Martin Manning	US		Co-chair of IPCC WG 1 and former chair of IPCC WG 1	F M	

2008	Donald Kennedy	David Baltimore	US		President of the AAAS and Robert A. Millikan Professor at the California Institute of Technology	M
2007		Donald Kennedy	US	DC	Editor in Chief	M
2007		Donald Kennedy	US	DC	Editor in Chief	M
2007		Donald Kennedy	US	DC	Editor in Chief	M
2007		John P. Holdren	US		President of AAAS, Director of Wood Hole Research Centre and president of STS programme at Harvard University	M
2007		Donald Kennedy	US	DC	Editor in Chief	M
2007		Donald Kennedy	US	DC	Editor in Chief	M
2007		Donald Kennedy	US	DC	Editor in Chief	M
2007		Donald Kennedy	US	DC	Editor in Chief	M
2007		Donald Kennedy	US	DC	Editor in Chief	M
2007		Donald Kennedy	US	DC	Editor in Chief	M
2007		Donald Kennedy	US	DC	Editor in Chief	M
2007		Ian Lowe	Australia	Brisbane	Emeritus Professor	M
2007		Rosina M. Bierbaum and Peter H. Raven	US		Scientific Expert Group (SEG) on Climate Change and Sustainable Development	M F
2007		Colin Challen	UK		Member of Parliament/Chair of the All Party Parliamentary Climate Change Group	M
2007		R.K Pachauri	India	New Delhi	Energy and Resource Institute, Chair of the IPCC	M
2006		Donald Kennedy	US	DC	Editor in Chief	M
2006		Donald Kennedy	US	DC	Editor in Chief	M
2006		Donald Kennedy and Brooks Hanson	US	DC	Editor in Chief and Deputy Editor at Science	M
2006		Donald Kennedy	US	DC	Editor in Chief	M
2006		Donald Kennedy	US	DC	Editor in Chief	M
2006		Donald Kennedy	US	DC	Editor in Chief	M
2006		Granger Morgan	US	Pittsburg	Head of department of engineering and public policy at Carnegie Mellon	M
2006		William H. Schlesinger	US	Durham (US)	Dean of the Nicholas School of the Environment and Earth Sciences	M
2006		Steven E. Koonin	UK (but from the US)	London	Chief scientist, BP	M
2006		Keith Alverson and D. James Baker	US		IOC UNESCO	M M
2006		Chris Somerville	US	Stanford	Academic	M
2006		Martin Rees	UK	Cambridge	President of Royal Society	M
2005		Donald Kennedy	US	DC	Editor in chief	M
2005		Donald Kennedy	US	DC	Editor in Chief	M
2005		Donald Kennedy	US	DC	Editor in Chief	M
2005		Chris Huntingford and John Gash	UK	Wallingford	Center for Ecology and Hydrology	M
2004	Donald Kennedy	US	DC	Editor in Chief	M	
2004	Donald Kennedy	US	DC	Editor in Chief	M	
2004	Donald Kennedy	US	DC	Editor in Chief	M	
2004	Richard A. Meserve	US	DC	President of the Carnegie Institution of Washington/Chairman of International	M	

				Nuclear Safety Group of the International Atomic Energy Agency	
2004	David Baltimore	US	California	President of the California Institute of Technology in Pasadena	M
2004	Jeffrey D. Sachs	US	New York	Director of the Earth Institute at Columbia University and Special Advisor to United Nations Secretary-General Kofi Annan on the Millennium Development Goals	M
2004	Mary R. Albert	US		Chair of the U.S. Planning Committee for IPY 2007–2008	F
2004	Robert B. Gagosian	US		President and director of the Woods Hole Oceanographic Institution in Woods Hole, Massachusetts, and a member of the U.S. Commission on Ocean Policy Science Advisory Panel	M
2003	Donald Kennedy	US	DC	Editor in Chief	M
2003	Donald Kennedy	US	DC	Editor in Chief	M
2003	Donald Kennedy	US	DC	Editor in Chief	M
2003	Donald Kennedy	US	DC	Editor in Chief	M
2002	Donald Kennedy	US	DC	Editor in Chief	M
2002	Donald Kennedy	US	DC	Editor in Chief	M
2002	Donald Kennedy	US	DC	Editor in Chief	M
2002	Crispin Tickell	US	DC/Boston	Senior visiting fellow at the Harvard University Center for the Environment and chairman of the Climate Institute	M
2002	Kirk R. Smith	US	California	Professor of environmental health sciences	M
2002	Tony McMichael	Australia	Canberra	Director of National centre for epidemiology and population health,	M
2001	Saleemul Huq	UK and Bangladesh		Chairman of the Bangladesh Centre for Advanced Studies in Dhaka, Bangladesh, and director of the Climate Change Programme of the International Institute for Environment and Development in London	M
2001	Jonathan Lash	US	DC	President of the World Resources Institute in Washington	M
2001	Joint Statement			Joint statement by different academies of science	n.a.
2001	Donald Kennedy	US	DC	Editor in Chief	M
2001	John Lawton	UK		Academic/Chief executive of the UK Natural Environment Research Council.	M
2001	Donald Kennedy	US	DC	Editor in Chief	M
2000	Norman Myers	UK		British environmentalist	M
2000	Philip Abelson	US	DC	Deputy Editor of Science	M
2000	Philip Abelson	US	DC	Deputy Editor of Science	M
2000	Philip Abelson	US	DC	Deputy Editor of Science	M
2000	Donald Kennedy	US	DC	Editor in Chief	M
1999	Rush Holt	US		U.S. Congressman from central New Jersey/Physicist	M
1997	Gro Harlem Brundtland	Norway		Norwegian politician	F
1997	Robert M. May	UK/Australia		Chief scientific adviser to HM Government and Office of Science and Technology committee	M
1997	Philip Abelson	US	DC	Deputy Editor of Science	M
1996	Vice President Al Gore	US	DC	Vice President. Editorial text adapted from a speech for AAAS annual meeting	M

1995		George A. Olah	US	California	Academic/ Nobel Prize for work on carbocations	M
1995		Philip Abelson	US	DC	Deputy Editor of Science	M
1993		Brooks Hanson	US	DC	Senior Editor of Science	M
1993		Daniel Koshland	US	DC	Editor in Chief	M
1992		F. Sherwood Rowland	US	California	Professor of chemistry, President of AAAS	M
1992		Philip Abelson	US	DC	Deputy Editor of Science	M
1992		Philip Abelson	US	DC	Deputy Editor of Science	M
1992		Brooks Hanson and David Voss	US	DC	Both senior editors at Science	M M
1992		Philip Abelson	US	DC	Deputy Editor of Science	M
1992		Philip Abelson	US	DC	Deputy Editor of Science	M
1991		Philip Abelson	US	DC	Deputy Editor of Science	M
1991		Philip Abelson	US	DC	Deputy Editor of Science	M
1990		Philip Abelson	US	DC	Deputy Editor of Science	M
1990		Philip Abelson	US	DC	Deputy Editor of Science	M
1990		Philip Abelson	US	DC	Deputy Editor of Science	M
1990	Daniel Koshland	R. Brooks Hanson	US	DC	Senior Editor of Science	M
1990		Philip Abelson	US	DC	Deputy Editor of Science	M
1989		Daniel Koshland	US	DC	Editor	M
1989		Philip Abelson	US	DC	Publisher	M
1989		Philip Abelson	US	DC	Publisher	M
1989		John I. Brauman	US	DC	Deputy Editor of Science	M
1989		Philip Abelson	US	DC	Publisher	M
1989		Daniel Koshland	US	DC	Editor	M
1989		Philip Abelson	US	DC	Deputy Editor of Science	M
1989		Philip Abelson	US	DC	Publisher	M
1988		Daniel Koshland	US	DC	Editor	M
1988		Daniel Koshland	US	DC	Editor	M
1988		Phil Abelson	US	DC	Deputy editor	M
1986		Phil Abelson	US	DC	Deputy editor	M
1986		Phil Abelson	US	DC	Deputy editor	M
1985		Roger Revelle	US	California	Professor of science and public policy, University of California	M
1983		Phil Abelson	US	DC	Editor	M
1982		Gilbert F. White	US	Colorado	Academic, behavioural sciences	M
1979		Phil Abelson	US	DC	Editor	M
1979		William D. Carey	US	DC	Executive Officer of the AAAS from 1975 through 1987	M
1978		Robert G. Fleagle	US	DC	Department of Atmospheric Science, University of Washington	M
1978		Edward E. David	US	DC	President elect AAAS and President EXXON research and engineering	M
1977		Charles J. Hitch	US	DC	Resources for the future	M
1977		Phil Abelson	US	DC	Editor	M
1976		Phil Abelson	US	DC	Editor	M
1976		Phil Abelson	US	DC	Editor	M
1975	Phil Abelson	William D. Carey	US	DC	Executive Officer of AAAS and publisher of Science from 1975 through 1987	M

1974	Alvin Weirberg	US	DC	Federal Energy Agency	M
1972	Phil Abelson	US	DC	Editor	M
1970	Fred Singer	US	DC	Chairman, Committee on Environmental Quality, AGU	M
1967	Phil Abelson	US	DC	Editor	M
1966	Walter Orr Robert	US	Colorado	Director, NCAR	M
1966	Phil Abelson	US	DC	Editor	M

In their personally authored editorials the distinction is even clearer. Of Abelson's 31 authored editorials between 1966 and 2000, 87% framed climate change primarily as either a technology/energy challenge (TECH; n=16) or a scientific challenge (SCI; n=11). In contrast, of Kennedy's 31 authored editorials between 2000 and 2010, 39% were a communication challenge (COM; n=12) and 23% each as a technology/energy challenge (TECH) and an institutional/governance challenge (GOV). These editors' disciplinary backgrounds and personal commitments are likely significant here: Abelson, a physicist with a strong background in nuclear energy and a personal interest in global energy challenges; Kennedy, a biologist but with strong interests in public policy and global climate change.

*Supplementary Table 3: Number of 'climate change editorials' in Science published under each editor-in-chief, together with the number of editorials they each personally authored. Note: some editorials were authored by EICs after their tenure as editor. The predominant 'challenges' framed by the editorials under each EIC's tenure is also indicated (refer back to Table 2 in main text for codes).*

Editor	Dates	Total commissioned	%	Predominant frames amongst those commissioned	Personally authored	%
Phil Abelson	1966-1984	17	11	10xSCI 5xTECH	31	19
Daniel Koshland	1984-1995	29	18	13xSCI 10xTECH	5	
Flood Bloom	1995-2000	7	4	3xTECH 2xDEV	0	
Donald Kennedy	2000-2008	60	38	16xTECH 13xCOM 12xGOV 8xSCI	31	19
Bruce Albert	2008-2013	25	16	8xSCI 7xCOM 4xTECH	2	
Marcia McNutt	2013-2015	19	12	5xTECH 4xCOM 3xGOV	9	
Jeremy Berg	2015-2016	3	2		0	

Supplementary Table 2 allows further analysis of the author profiles of *Science*'s editorials. Some 91 editorials (57%) were authored by *Science*'s EICs, deputy editors, senior editor publishers or others working for the AAAS. This is consistent with *Science* being the flagship journal of the American Association for the Advancement of Science. 84% of editorials were authored by individuals located in the USA (Supplementary Table 4) and of these, about two thirds were located in Washington DC. (This is an estimation since some authors have multiple affiliations and may reside in different places). With regards to gender, only 17 (11%) of all *Science* editorials were single authored by women (a further eight were co-authored by women), and nine of these were authored by the first female EIC of *Science*, Marcia McNutt. Before McNutt took over as EIC in 2013, only four out of 138 editorials in *Science* had been single-authored by a woman.

*Supplementary Table 4: Location of authors of Science's climate change editorials*

	<b>USA</b>	<b>Europe</b>	<b>Rest of the World</b>	<b>Total</b>
<b>Number</b>	135	17	8	160
<b>%</b>	84	11	5	

*Supplementary Table 5: Inter-coder reliability scores from the two pilot exercises.*

*'Attributes' were only coded in the second pilot.*

<b>Fleiss kappa scores</b>	<b><i>Nature</i></b>	<b><i>Science</i></b>
Pilot 1 'challenges'	0.17	0.35
Pilot 2 'challenges'	0.32	0.39
Pilot 2 'attributes'	0.66	0.65