its skill in capturing the climate response to complex temporally and spatially evolving inhomogeneous forcings (for example, recent shifts in aerosols from more northerly developed to more equatorial developing nations) are surely required. Thus, the conclusions of my paper hold firm, namely that the geographic distribution of radiative forcing plays an important role in determining the transient climate response, and that calculations with simple models and those inferring transient climate response from historical surface temperature observations need to adequately account for this. ❐

References
1. Smith, S. J., Wigley, T. M. L., Meinshausen, M. & Rogelj, J. *Nature Clim. Change* **4,** 741-742 (2014).
2. Shindell, D. T. *Nature Clim. Change* **4,** 274–277 (2014).
3. Shindell, D. *et al. J. Geophys. Res.* **115,** D19110 (2010).
4. Shindell, D. & Faluvegi, G. *Nature Geosci.* **2,** 294–300 (2009).
5. Shindell, D. T. *Atmos. Chem. Phys.* **12,** 7955–7960 (2012).
6. Stuber, N., Ponater, M. & Sausen, R. *Clim. Dynam.* **24,** 497–510 (2005).

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COMMENTARY:

Breaking the climate change communication deadlock

Adam Corner and Christopher Groves

Climate change communication is trapped between the norms that govern scientific practice and the need to engage the public. Overcoming this tension requires new societal institutions where the science and politics of climate change can co-exist.

Over more than two decades, a substantial body of social science research has generated a range of well-supported findings with clear, practical implications for public engagement on climate change[1]. It is now well understood that effective climate change communication involves more than simply presenting the facts of climate science in a clearer or more concise way. The idea that members of the public suffer from a 'deficit' of knowledge (which science outreach campaigns can address) is insufficient to explain the gap between the social and the scientific consensus on climate change that appears to have emerged over the past 10 years — particularly in the United States, the United Kingdom and Australia, despite extensive programmes of outreach and engagement in these countries[2]. Although the reasons for public scepticism about climate change are complex and multi-faceted[3], a consistent finding is that deeply held values and views about the organization of society and political ideology[4] are primary determinants. Strikingly, improved scientific literacy in an audience can actually amplify polarization between ideologically opposed groups[5], rather than lead to consensus between them.

In response to this increasingly troubling contrast between the urgency of the message conveyed by scientists and the lack of a political and public response proportionate to the scale of the climate change challenge, there have been multiple calls for climate science to put its communicative house in order. Scientists have been advised to develop simple, repetitive messages that can be honed for public consumption[6], to 'stand up for their science' and 'set the record straight'[7], to speak truth to power[8] and to get arrested if necessary[9]. But for the most part, the recommendations and rousing calls to arms have not translated into changed communicative practices or elevated levels of public engagement. We argue here that a 'deadlock' prevails because of a fundamental tension between the norms of scientific practice and those that govern the social

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space in which debate about climate change occurs. In response, we identify a need for new societal institutions that can ease this normative tension.

Normative tensions

Debates about the appropriate role for scientists when interacting with policymakers, endorsing the aims of civil society campaign groups or engaging in 'issue advocacy' have been rehearsed many times and we do not seek to resolve them here[10,11]. But in general, the norms of scientific practice tend towards a disinterested, neutral or even objective role for scientific experts. Scientists are part of a professional community in which normative authority — the ability to make statements that other scientists will take as good reasons to change their beliefs about the world — is relatively straightforward[12]. A claim that conforms to the prescriptions of the scientific method must be taken seriously: it is tentatively accepted until further evidence is forthcoming. But the instant that science leaves the laboratory (as it must, if it is to have any bearing on the world beyond) a different set of norms kicks in.

For the vast majority of people who are not climate scientists, almost every aspect of climate change is mediated in some way — through scientific institutions, media outlets, or individuals with whom they may or may not identify. Their mediated judgements are based on very different factors from those that govern scientific conduct — such as the cultural congruence between the communicator of a message and their own views, or the extent to which the apparent policy implications of climate science threaten or challenge their values[4,5]. Implicitly, social identities, ideological frameworks and personal values are answers to the philosophical question 'how shall we live?' Reasons that convince people to change their beliefs about how to live are ones that make sense within this space, namely social, ethical or political ones. What scientists would accept as a reason for changing their beliefs about the world they investigate does not, therefore, necessarily count as a good reason for changing one's beliefs about how to live, or for actually living differently[13].

At the same time, climate change research (like research on public health[14]), concerns fundamental features of the world we live in. Because of this, the theologian Michael S. Northcott describes climate change research as inherently political: its description of the world contains an implicit judgement on the question of how we should live[15]. Consequently, climate change cannot be communicated more effectively and simultaneously insulated from the norms of debate that govern the public sphere. If, as research funders increasingly insist, scientists ought to engage the public, they face a conundrum: embrace the norms that govern the social domain (where values, ideology and social identity shape the debating space) and effectively engage their audience, or stay within the boundaries that define professional scientific practice and commit to a strategy that is very likely to fail.

New societal institutions

Similar normative tensions arise in other fields (for example, promoting health behaviours), where researchers seek to not only describe the risks of smoking and over-eating, but also convince the public to refrain from engaging in these unhealthy behaviours[14]. Because these normative aims are no longer widely contentious, they barely seem normative at all. A process of self-reflection by the diverse representatives (research funders, social scientists, natural scientists and actors at the science/policy and science/public interface) that comprise the climate change communication community is therefore a crucial first step, as highlighted by Rapley and De Meyer in their Commentary in this issue[16]. Why is it that engaging the public based on strongly and overtly normative goals is acceptable in the health domain, but not for climate change?

The practical implications of changing this situation might include the following: tell human stories about the impacts of climate change that connect with the values of diverse audiences[17]; construct narratives that situate individual-level behaviour change as part of a coordinated global strategy for reducing fossil-fuel consumption[18]; promote representatives from disparate social and political backgrounds to act as culturally congruent conduits for communicating climate change[19]. But are these activities that scientists could reasonably, usefully pursue? Are they even aims that collaborative efforts between natural and social scientists could take up[1]?

Our contention is that such efforts are undermined because the appropriate societal institutions do not yet exist to accommodate and ease the normative tensions within climate change communication. Scientists certainly have a role to play, but they cannot overcome the tensions on their own. Efforts should be concentrated on creating and supporting new institutions and societal infrastructure that provide a buffer between the science of climate change and the complex challenge of engaging the public. These institutions should be explicitly tasked with carving out new space between the normative tenets of scientific research and public engagement. Fischhoff[20] recommends that in these types of collaboration, scientists stick to strictly non-persuasive communication. But in the same way that climate science is inherently political, communicating about climate change is unavoidably persuasive — not of a particular policy or goal, or in favour of a particular party or outcome, but of the basic assertion that anthropogenic climate change is real, is a serious problem and requires a serious societal response.

The purpose of these new, hybrid institutions would be to catalyse new conversations about climate change. These events would not be designed to make an economic case, communicate scientific facts or win an argument, but to allow people to express and discuss their concerns, fears, dreams and hopes for the future, providing answers to that troubling question 'how shall we live?' They would involve explicitly political voices and views, but not themselves pursue politicized ends. Isolated examples of these kinds of initiative have taken place before (for example, World Wide Views (www.wwviews.org), an exercise involving hundreds of people from around the world just prior to the United Nations climate change negotiations in Copenhagen in 2009). When they have occurred, a striking pattern has been observed: people move from a lack of interest to a position of engaged concern[21].

This is an argument for more — not less — politics in climate change communication. To be clear: this does not mean aligning the goals of climate science with the advocacy strategies of a campaign group. But through a diversity of partnerships with actors from across the social and political spectrum, concerns about partisan influence can in effect be neutralized. The acceptance that everyone approaches climate change with their own ethical and political values — and that engaging with these is an appropriate aim for climate change communication — would be a major step towards easing the normative tensions at the heart of the field. ❐

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References

1. Pidgeon, N. F. & Fischhoff, B. *Nature Clim. Change* **1,** 35–41 (2011).
2. Brulle, R. J., Carmichael, J. & Jenkins, C. *Climatic Change* **114,** 169–188 (2012).
3. Capstick, S. B. & Pidgeon, N. F. *Glob. Environ. Chang.* **24,** 389–401 (2014).
4. Corner, A. J., Markowitz, E. & Pidgeon, N. F. *WIREs Clim. Change* **5,** 411–422 (2014).
5. Kahan, D. M. *et al. Nature Clim. Change* **2,** 732–735 (2012).
6. Rapley, C. *Nature* **488,** 583–585 (2012).
7. Maibach, M., Myers, T. & Leiserowitz, A. *Earth's Future* **2,** 295–298 (2014).
8. Anderson, K. & Bows, A. *Nature Clim. Change* **2,** 639–640 (2012).
9. Grantham, G. *Nature* **491,** 303 (2012).
10. Pielke, R. A. Jr *The Honest Broker: Making Sense of Science in Policy and Politics* (Cambridge Univ. Press, 2007).
11. Nelson, M. P. & Vucetich, J. A. *Conserv. Biol.* **23,** 1090–1101 (2009).
12. O'Neill, J. *Ecology, Policy and Politics* (Routledge, 1993).
13. Haller, S. F. *Apocalypse Soon? Wagering on Warnings of Global Catastrophe* (MQUP, 2002).
14. Chapman, S. *Int. J. Epidemiol.* **30,** 1226–1232 (2001).
15. Northcott, M. S. *A Political Theology of Climate Change* (William B. Eerdmans, 2013).
16. Rapley, C. & De Meyer, K. *Nature Clim. Change* **4,** 745–746 (2014).
17. Corner, A. & van Eck, C. *Science and Stories: Bringing the IPCC to Life* (Climate Outreach and Information Network, 2014).
18. Rowson, J. *A New Agenda on Climate Change: Facing Up to Stealth Denial and Winding Down on Fossil Fuels* (RSA, 2013).
19. Jones, M. D. *Soc. Sci. Quart.* **95,** 1–39 (2014).
20. Fischhoff, B. *Environ. Sci. Technol.* **41,** 7204–7208 (2007).
21. Dietz, T., Stern, P. C. & Dan, A. *Land Econ.* **85,** 329–347 (2009).

COMMENTARY:

Climate science reconsidered

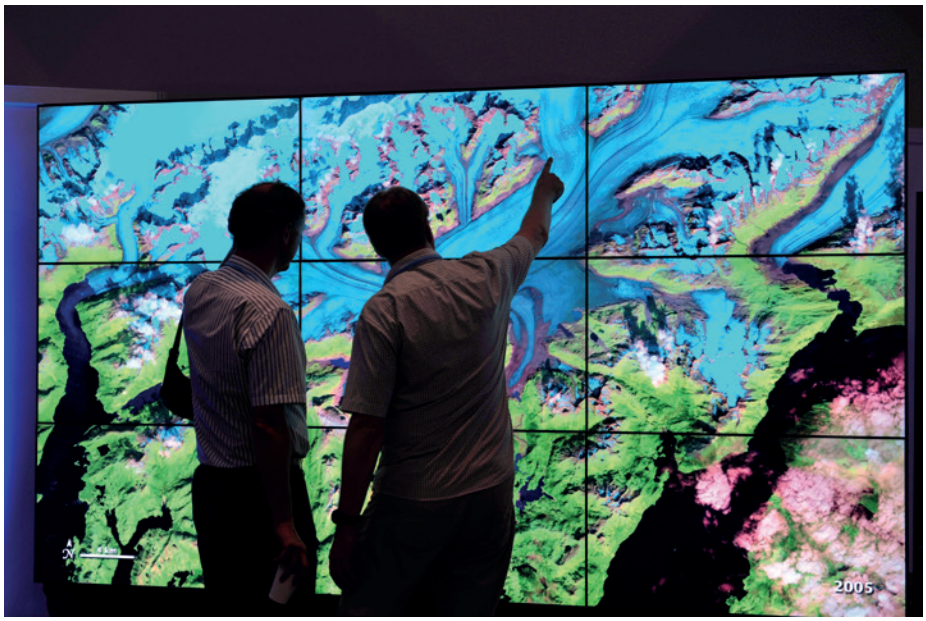
Chris Rapley and Kris De Meyer

There is a gap between the current role of the climate science community and the needs of society. Closing this gap represents a necessary but insufficient step towards improved public discourse and more constructive policy formulation on climate change.

How should climate scientists balance their efforts between investigating the climate system and engaging with policymakers and the public? When engaging, should they merely aim to inform policy, or should they advocate specific actions? In a newly published study[1] we argue that these questions are unresolved, and that there is a gap between the role of the climate science community and the needs of society. The implications of climate science merit widespread constructive and thoughtful discussion. Yet the public discourse is commonly fraught with contention, and climate scientists often find themselves on the receiving end of emotionally charged reactions to their work. To help turn this situation around, we encourage the community to reconsider its professional practices, skills and norms, and to adjust its training and development activities accordingly.

This is not the first time such a call has been issued. In 1997, Jane Lubchenco — then newly appointed as President of the American Association for the Advancement of Science — delivered a speech[2] in which she underscored the extent of the human impacts on the ecological systems of the planet and the intimate connections of these systems with human health, the economy, social justice and national security. She saw it as incumbent on researchers to reflect on the nature of their responsibilities to society, and to evaluate the extent to which they were fulfilling them. She invited the science community to "participate vigorously in exploring the relationship between science and society and in considering a New Social Contract for Science as we enter the Century of the Environment".

In the event, the 'vigorous exploration' did not materialize. We suggest in the report that this is due in part to a rapid increase in research responsibilities, which, albeit with exceptions, has led busy individuals to focus on their science rather than to take on additional commitments in the areas of public discourse and policy. More fundamentally, there is a lack of a formal mechanism by which climate scientists can discuss these issues or receive



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European space scientists view NASA data visualizations during the 18th Session of the Conference of the Parties to the United Nations Framework Convention on Climate Change in Doha, Qatar, 2012. With nearly 200 countries working towards a new policy agreement on climate change at the 21st Session in Paris in December 2015, climate scientists have an important role to play in the outcome.