Received: 18 January 2018 | Revised and accepted: 3 July 2018

DOI: 10.1002/wcc.547

WILEY WIREs CLIMATE CHANGE

ADVANCED REVIEW

The IPCC and the new map of science and politics

Silke Beck[1] | Martin Mahony[2]

[1]Department of Environmental Politics, Helmholtz Centre for Environmental Research – UFZ, Leipzig, Germany

[2]School of Environmental Sciences, University of East Anglia, Norwich, UK

Correspondence
Silke Beck, Department of Environmental Politics, Helmholtz Centre for Environmental Research – UFZ, ermoserstraße 15, 04318 Leipzig, Germany.
Email: silke.beck@ufz.de

Funding information
German DFG in the context of the Priority Program Climate Engineering: Risks, Challenges, Opportunities, Grant/Award Number: SPP 1689; University of Nottingham International Collaboration Fund

Edited by Mike Hulme, Editor-in-Chief

In this study, we review work which seeks to understand and interpret the place of the Intergovernmental Panel on Climate Change (IPCC) within the science and politics of climate change in the context of a post-Paris polycentric governance regime and the culture of "post-truth" politics. Focusing on studies of how the IPCC has sought to maintain a boundary between the scientific and the political, we offer an historical account of "boundary work" within the IPCC which is instructive for thinking, in an anticipative mode, about emerging and likely challenges to the IPCC's position as a science–policy boundary organization. We suggest that the relationships between climate science and policy are undergoing fundamental transformation in light of the Paris Agreement, and contend that the IPCC will need to be nimble and reflexive in meeting new challenges. Growing calls for more "solution-oriented" assessment question the IPCC's positioning at the science—politics boundary, where it can function to put some policy options on the table, while obscuring others. Recent controversies over proposed mitigation solutions are indicative of likely future challenges. We suggest that by adopting a mode of "responsible assessment," the IPCC can continue to exercise its world-making power in a relevant and legitimate fashion.

This article is categorized under:
Social Status of Climate Change Knowledge > Climate Science and Decision Making

KEYWORDS
BECCs, IPCC, negative emissions, Paris Agreement, pathways

1 | INTRODUCTION

In the emerging post-Paris climate policy regime, the role of scientific knowledge and expertise is arguably undergoing a far-reaching transformation. On the one hand, there is the resurgence of climate skepticism in the U.S. Government, and the proposed U.S. withdrawal from the Paris Agreement, which perhaps heralds a rerun of battles over the very truth of global warming. On the other hand, and arguably more significant for the making and implementation of climate policies worldwide, climate science is being asked to perform a new role. This role is arguably less about providing scientific evidence for the existence of global warming, and more about contributing to the implementation and monitoring of policy actions.

In this review, we examine what this means for the conduct of climate knowledge-making, focusing in particular on the Intergovernmental Panel on Climate Change (IPCC) which has been established as the authoritative voice of international science. As the terrain between science and politics shifts, new attention is needed on how climate science is and can be positioned on this new map. We consider how the IPCC has positioned itself relative to science and policy, that is, the "boundary work" it employs, and in turn how this may impact on, and be impacted by, challenges that the organization may face in a

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post-Paris climate policy landscape. The article goes beyond reviewing the boundary work literature to create a framework to apply and reinterpret research on the IPCC as a boundary organization by situating the IPCC in its broader societal context, and explores how the IPCC is part of and responds to recent transformations of society. It therefore starts from a unique angle by taking into account how the IPCC has been responsive to internal and external challenges in the past, before reflecting on likely challenges in the future, in the context of a post-Paris polycentric governance regime and a culture of "post-truth" politics. Amid all this, we emphasize the "performative" power of IPCC assessments to shape fields of political possibility—to put certain policy options on the table, while potentially obscuring others. We suggest that understanding these trends and processes through the lens of "boundary work" can aid the understanding and practice of the science–policy relationship.

In the next section, we introduce the concept of "boundary work," showing how and why it has been used as a common concept in different approaches to analyzing the science–policy interface. We suggest there is benefit to understanding boundary work and its effects at different levels—cognitive, sociopolitical, and spatial—and then use this framework to reinterpret existing research on the IPCC as a science–policy "boundary organization." Based on our framework of boundary work, we also take into account the changing societal context and then turn to emerging questions about the future role of the Panel in a changing and increasingly polycentric policy regime. We explore how our framework helps illuminate particular aspects of present challenges and bring out their significance, their potential impact on the IPCC and how they might mediate them. Recent debates about the (mis)functioning of the science–policy interface in the context of negative emissions technologies (NETs) provide a useful way into these questions. We suggest that assessment processes like the IPCC must increasingly take into account their changing political contexts and implications in a systematic way. In the final section, we offer the notion of "responsible assessment" as one potential mode of institutional reflexivity about the multiple effects of knowledge-making in the science and politics of climate change.

2 | BOUNDARY WORK

The ideal of political neutrality in scientific advisory and assessment processes serves as an important principle, shaping the public performance of scientific communities, based on a clear-cut and stable boundary between science and politics. However, historians and sociologists of science have shown how the relationship between science and politics in practice is not as stable or clear-cut as often assumed. The relationship between science and politics is dynamic, open to change, and plays out differently in different times and places. In this section, we review different approaches to understanding this relationship, focusing on examples from the environmental sphere. Gieryn (1983, p. 782) defined "boundary work" as the "ideological efforts by scientists to distinguish their work and its products from nonscientific intellectual activities." Following this seminal definition, boundary work is often understood (in STS) as an instrument to prevent external control over scientific work and protect the autonomy of science. Elzinga (1997, p. 417) observes that historically, the more that science got intertwined with the "business of society" the more the image of a purity and disengagement of basic research was promoted by the scientific community (Latour, 2012). In a similar way, Jasanoff defines "boundary work" as a strategy to defend the exclusive authority over the interpretation of scientific findings in science or science-based public controversies. Boundary work serves as a means to gain control over key issues and thus to maintain or defend epistemic authority (Jasanoff, 1990). Defining an issue as a matter of science or politics is understood as a form of delegation and social ordering (Mahony, 2013). Boundary work thus is related to the symbolic power (Hughes, 2015) to allocate epistemic and political authority by defining who belongs within an expert collective and hence is entitled to speak for it, as well as who does not belong and hence lacks such authority (Jasanoff, 1990). Scholars have used the concept to describe how the boundary between science and politics is constantly negotiated in practice (Guston, 2001; Hoppe, Wesselink, & Cairns, 2013; Mahony, 2015). In turn, the "boundary organization" concept was introduced to study how science is organized as a form of expertise in policy-making and to understand how processes of producing expertise and policy-relevant knowledge are designed, managed and work in practice, often with large amounts of "boundary work" involved (Guston, 2001; Miller, 2001). For Guston, boundary organizations sit "at the frontier of the relatively different social worlds of science and politics, but they have distinct lines of accountability to each." They "involve the participation of actors from both sides of the boundary," and often involve the creation of what STS scholars call "boundary objects"—tools or items of knowledge which are flexibly employed in different social worlds, for different purposes (Guston, 2001, p. 401). Temperature targets like 2 °C or 1.5 °C would be one example of boundary objects which straddle science and politics, and structure action in both worlds (Lahn & Sundqvist, 2017; Mahony, 2013; Randalls, 2010).

Scholars in sustainability science (Clark et al., 2016), interpretative political science (Turnhout, Dewulf, & Hulme, 2016; Wackers & Markussen, 2015; Wesselink, Buchanan, Georgiadou, & Turnhout, 2013) and international relations (IR) (Allan, 2017; Compagnon & Bernstein, 2017; Corry & Stevenson, 2017; Gustafsson & Lidskog, 2017; Hughes & Paterson, 2017; Lidskog & Sundqvist, 2015; Morin, Louafi, Orsini, & Oubenal, 2016) have cast "boundary work" in slightly different terms.

In the emerging field of sustainability science, Clark et al. (2016), for instance, describe "boundary work" as means through which research communities organize their relations with the worlds of policy-making. They develop a framework whereby they analyze boundary work as a strategy to improve the credibility, salience, and legitimacy of experts and thus the effectiveness of knowledge systems. Others have defined boundary work in a similarly broad sense, to mean work and activity at the boundary between science and politics, in so doing taking the existence and location of the boundary for granted (Clark et al., 2016; Haas, 1992). The important distinction between these more practical–procedural approaches found in sustainability science, IR and elsewhere, and interpretative approaches (including STS and more critical approaches to IR), is that for the former scholars, the effectiveness of advisory bodies is dependent on their autonomy from and thus the separation between knowledge production from political action (Haas, 1992). By contrast, interpretative scholars insist that it is the mutual cooperation and negotiation, the interdependence between science and politics that offers the glue which holds expertise and policy-making together (Forsyth, 2003; Guston, 2001, p. 402; Jasanoff, 1990; Latour, 2012). However, some empirical studies have indicated the mutual interdependence of both dimensions. The work of Tuinstra, Hordijk, and Kroeze (2006) demonstrates how "boundary work" has two elements: A demarcation side *separating* two "units" by defining distinguishing tasks and prescribing proper rules of procedures for, for example, expert reviews and stakeholder participation, and a *coordination* side defining how the two relate to each other by defining proper mutual conditions of exchange (also Sundqvist, Bohlin, Hermansen, & Yearley, 2015).

Different authors have used these approaches to understand how the IPCC has been able to respond to (diverging) challenges and thus to maintain the political relevance and scientific integrity of its work despite intense political pressures, tight deadlines and a continually evolving, multidisciplinary scientific field (eg, Beck, 2011, 2012a; Edwards & Schneider, 2001; Hulme, 2016; Miller, 2001). They also try to take into account the broader changing context in which the IPCC is embedded and the novel external challenges to which the IPCC has to respond. Miller (2001) identifies the challenges of addressing the more complex situations in which international boundary organizations navigate while not being able to lean on well-defined norms of relating science and politics that often exist in national contexts. One such challenge is navigating the "diverse array of hybrid and institutional types that relate to one another as well as to scientific and political institutions" (p. 484). Research into boundary work in different intellectual traditions has helped uncover how and why organizations operating at the science–policy interface able are to perform their scientific and political task while maintaining their epistemic and political authority (Edwards & Schneider, 2001; Elzinga, 1997; Guston, 2001; Hoppe, Driessen, & Leroy, 2010). Recently, there have been encouraging attempts to bring together these different approaches in IR and STS (such as Lidskog & Sundqvist, 2015) and to focus on the configuration of science in society and explore how science and politics are part of broader transformations of society, conceptualized for example in terms of regime analysis (Barben, 2007; Winickoff & Mondou, 2017). While research in different traditions—STS, IR, and sustainability science—has asked different questions of boundary work (Hughes & Paterson, 2017), a major conclusion of all this work is that, as societal and political contexts change, the organization, design, and strategies of institutions like the IPCC will need to adapt. In the next section, we examine how this has happened in the history of the IPCC to date. We seek to beyond reviewing the existing boundary work literature by developing a framework to apply and reinterpret research on the IPCC as a boundary organization. In order to navigate through the different ways of conceptualizing boundary work, we introduce a classification of boundary work across cognitive, sociopolitical, and spatial levels. We use this classification to structure the section that follows. At the *cognitive* level, we refer to efforts to adjudicate the demarcation of facts/values, is/ought, description/prescription. By *sociopolitical*, we refer to the divisions of labor and tasks, and to what Guston (2001) calls "lines of accountability" and forms of delegation of epistemic and political authority, and thus efforts to define who counts as a legitimate expert or representative to be included into the IPCC and its subpanels. By *spatial*, we refer to the geographical elements and outcomes of the preceding forms of boundary work, in terms of the resulting under-representation of certain countries or areas, or in the prioritizing of "global" rather than "local" forms of knowledge (Hulme, 2010). These micropolitics shape the set-up and adjustment of the IPCC's institutional arrangements, its rules of procedure and governance structures, and have important implications for the content of the IPCC reports and their subsequent impact (Beck, Forsyth, Kohler, Lahsen, & Mahony, 2016; Skodvin, 2000b; Sundqvist et al., 2015, 2017).

3 | BOUNDARY WORK AND THE IPCC

In the next section, we use this framework to reinterpret existing research on the IPCC as a science–policy "boundary organization" at different levels—cognitive, sociopolitical, and spatial. We reconstruct the genesis and history of the IPCC with this lens, before going on to examine present and future challenges.

3.1 | A history of boundary work

3.1.1 | Boundary work at the cognitive level

The norm of "policy neutrality" has functioned as a powerful means of ensuring stability at the science/politics boundary, reinforcing a vision of science as being wholly "value-free" (eg, Betz, 2013) and capable of informing policy options without directing them. However, as Shaw (2005) argues, the ideals of objectivity and relevance are in constant tension, as determining and practicing what is "relevant" means some reneging on the strive to be wholly "disinterested" in the broader connotations and meaning of scientific inquiry (Merton, 1973). In "boundary organizations" like the IPCC, the constant negotiation of the science–politics boundary at this cognitive level is a crucial feature.

Early social–scientific engagements with the IPCC reflected these boundary troubles. Boehmer-Christiansen (1994a, 1994b) interpreted the IPCC as the manifest convergence of scientific, political and business interests which represented a threat to the integrity and independence of science, and she cautioned against the establishment of a single scientific voice for the climate debate in such a politically charged atmosphere. Boehmer-Christiansen's analyses came in for strident criticism (Moss, 1995). Shackley and Skodvin (1995) offered a careful rebuttal of Boehmer-Christiansen's thesis, suggesting that while the IPCC of course represented the convergence of many scientific and extra-scientific forces, such a "conspiratorial" (Shackley & Skodvin, 1995, p. 179) account of scientists seeking hegemony over policy mechanisms in order to secure further research funding failed to grasp the complexity of the unfolding epistemic politics (see also Oels, 2005). Shackley and Skodvin's call for interpretative social scientists to play a greater role in understanding the dynamics of IPCC processes has been heeded by many in recent years (for examples and overviews, see Demeritt, 2001; Elzinga, 1997; Hughes & Paterson, 2017; Hulme & Mahony, 2010; Mahony & Hulme, 2018; Miller, 2004; Shackley, 1997) and we now have a greater understanding of the mutual constitution of the scientific and the political in the IPCC process which doesn't grant undue agency or Machiavellian intentionality to any single group of actors participating in the process.

More recent work, using interviews, document analysis, and sometimes ethnographic observation (eg, O'Reilly, Oreskes, & Oppenheimer, 2012) has painted a detailed picture of boundaries and boundary work in the production of assessments. In a study of the social life of the "burning embers" diagram Mahony (2015) shows, echoing Fogel (2004, 2005), how disagreements between authors, reviewers and government delegations are often conducted through the rhetoric of scientific objectivity—governmental objections may be dismissed as being motivated by extra-scientific interests, while others seek to regulate the IPCC's ability to make strong claims by policing authors' engagement with questions—such as the definition of "dangerous" climate change—which touch upon questions of values and norms. As noted elsewhere in climate change debates (Latour, 2012; Luton, 2015), both "sides" often share a commitment to an ideal of science as a value-free process, which then enables them, through boundary work, to delegitimize the knowledge claims of opponents as being insufficiently "scientific."

3.1.2 | Boundary work at the sociopolitical level

Conflict over the correct position of the boundary between fact and value, description and prescription plays out in practices of boundary work which become sociopolitical; including choices about rules of membership for an expert organization, its lines of accountability to scientific and political communities, the standards by which it defines evidence, and its procedures for review and approval (Beck et al., 2016; Jasanoff, 2011).

A number of social scientists have praised the IPCC's capacity for asserting its independence from politics. Siebenhüner (2003, p. 121) suggests that the evolving structures and procedures of the IPCC have led to a "decreasing influence of national governments on the climate negotiation process through the assessment process" a change which he sees as positive for the maintenance of legitimacy and credibility. Edwards and Schneider (2001), writing about a controversy in the Second Assessment Report (SAR) over the conduct of the peer review process, offer an important "backstage" glimpse into the IPCC's capacity for self-organization in the shadow of concerted efforts to discredit the organization's practices and products. However, others (eg, Beck, 2011; Grundmann, 2007) have suggested that efforts to strengthen the boundary between the political and the scientific has "been achieved at the cost of greater procedural bureaucracy and complexity and hence loss of transparency and accountability" (Hulme & Mahony, 2010, p. 710).

Efforts to reinforce boundaries often occur in response to public controversies, and major shifts in the IPCC's practices have occurred in response to controversy and criticism. The IPCC's formal rules of procedure have undergone three major revisions, one in 1993, another in 1999, and a further round in 2010 (Skodvin, 2000a, 2000b). The 1999 changes were significant due to the introduction of review editors (a role subsequently strengthened in 2010), the establishment of formal rules governing the adoption of Synthesis Reports, and for the clarification of the conditions under which the use of nonpeer reviewed literature would be acceptable. These changes were partly driven by the detection and attribution controversy surrounding the SAR, which touched upon the delivery of key scientific evidence for the existence of global warming (Edwards & Schneider, 2001; Lahsen, 1999), in addition to a drive to accommodate a greater diversity of regional sources of knowledge in Working Group II's regionally-focused chapters (Hulme & Mahony, 2010).

In the course of formalizing rules of procedure, the IPCC faces an additional problem, namely, that of reconciling informal, decentralized and flexible modes of scientific self-organization with formalized, centralized, and hierarchical modes of coordination. The strategy of formalizing (Sundqvist et al., 2015) and standardizing procedures and matching them to consensus processes is double-edged: On the one hand, it is designed to contribute toward a greater coherence of governance structures and therefore to increase the political robustness of the organization, yet on the other hand it runs the risk of restricting the space available for independent self-organization within the climate science community and thus also the functionality of scientific procedures (Skodvin, 2000b).

This process of formalization was taken much further in the aftermath of the "Climategate" episode of 2009 to 2010 (Beck, 2012a) and the review commissioned from the InterAcademy Council (IAC, 2010; Hughes, 2015). As several authors have pointed out, different audiences have different criteria by which they judge the salience, legitimacy, and credibility of the IPCC; there is a sense in which the more monolithic the IPCC becomes, the more fragile its public edifice becomes—the very opposite of the robustness which formalization is meant to achieve (Hajer, 2012).[1]

These efforts at formalization are unevenly distributed. Indeed, an earlier suggestion that "informal rules based on the everyday practices of scientific communities guide the bulk of the work" carried out by the IPCC arguably still holds true (Edwards & Schneider, 2001, p. 227). By the same token, two other scientists with considerable personal experience have suggested that one of the unwritten rules observed within the organization is that the "IPCC shall depend uniquely on informal interactions among groups of scientists (authors) to develop its findings and avoid using formalized approaches" (Yohe & Oppenheimer, 2011, p. 633; see also Mach, Mastrandrea, Freeman, & Field, 2017).

The IPCC has been able to avoid some of the potential challenges of science–policy mediation due to the fact that the provision of technical knowledge directly to UNFCCC participants is handled by the Subsidiary Body for Scientific and Technological Advice (SBSTA), which plays a more responsive, mediatory role. For Miller (2001, p. 495), the UNFCCC's establishment of SBSTA was successful in constructing boundaries and conferring legitimacy, thus enabling the "maintenance of a productive tension between science and politics" (see also Oels, 2005, p. 198). Dahan-Dalmedico (2008) also argues that the existence of SBSTA allows the IPCC to avoid some of the criticisms associated with its challenging position at the meeting place of scientific advice and political action.

3.1.3 | Boundary work and the spatial

Boundary work at the cognitive and sociopolitical levels has had important implications for what we might think of as the "geographies" of the IPCC (cf. Mahony & Hulme, 2018). Distinctions drawn between facts and values, and between legitimate and illegitimate forms of membership and oversight, have had implications for global patterns of participation and trust, playing out differently in different Working Group contexts. Over its first assessment cycle (1988-1990), the IPCC operated in effect as *the* global setting for the negotiation of both the science and politics of climate change. Working Group III was essentially a space for debating the merits of policy alternatives, whereas its next manifestation in 1995 was the more apolitically framed "Economic and Social Dimensions of Climate Change." As Miller (2009) shows, a number of developing countries expressed a dissatisfaction at the first report's ambiguous positioning at the boundary of science and politics, and were wary of the IPCC becoming the only setting where a climate change governance architecture would be negotiated. For developing countries such as India, this would give scientifically dominant countries such as the US undue influence over the terms of the policy debate. The Intergovernmental Negotiating Committee was thus established in 1990 under the auspices of the UN, and was the institutional setting for the drafting of the UNFCCC and policy options (Bodansky, 2001). This act of boundary making strengthened the IPCC's self-identification as a scientific body, with a clear firewall established between deliberation which was "policy relevant" but "policy neutral" (Luton, 2015; Shaw & Robinson, 2004). In the first cycle of Working Group II, concerns were voiced by "western scientists regarding the management of the Working Group by the Soviets. This led the IPCC Bureau to impose some external pressure to ensure that a wider community of experts participated in the review of WG II chapters" (Agrawala, 1998, p. 624). Forms of boundary work interacted across the cognitive, the sociopolitical, and the spatial: A new cognitive firewall erected between facts and values; new arrangements for political oversight; new geographies of the power of national actors to set the terms of scientific and political debate.

These spatial questions have been approached through questions of representation and participation. While the representation of developing country scientists has improved over time, participation in IPCC assessments remains skewed toward the richest industrialized nations (Biermann, 2006; Corbera, Calvet-Mir, Hughes, & Paterson, 2016; Ho-Lem, Zerriffi, & Kandlikar, 2011). Others have also troubled the assumed correlation between participation, trust and legitimacy (Lahsen, 2004; Yamineva, 2017).

The incorporation of "grey literature" sources remains a challenge in relation to the representation of work and regions beyond the global centers of climate change research. This was arguably at the root of the controversies surrounding certain claims made in the AR4 Working Group II report concerning the loss of Himalayan glaciers. The use of such sources has long

been a cause for debate, and pits the IPCC's desire for scientific integrity in direct opposition with demands for comprehensive assessment of all aspects of climate change which are politically relevant (Skodvin, 2000b), and for assessment which is geographically balanced and representative (Ford et al., 2016; Obermeister, 2017). Boundary work in the cognitive mode, concerned with maintaining the integrity of the science, thus often becomes boundary work in a more spatial mode, potentially leading to the exclusion of knowledge about certain regions and places (Ford et al., 2016; Mahony & Hulme, 2018).

4 | SCIENCE AND POLITICS POST-PARIS

The gap between Paris temperature targets and Paris pledges (Canadell et al., 2017) has created frustration in the scientific community (Figueres et al., 2017). The recognition that, while global research programs and assessments have provided considerable understanding, they have not yet delivered comprehensive solutions, has triggered scientists to rethink the role of science in global policy-making. Part of this rethink demands recognition that parts of climate science are arguably being asked to operate in an increasingly "solution-oriented" mode (see Lee, 2015; also Guillemot, 2017; Kowarsch & Jabbour, 2017) and to perform a role akin to "regulatory science" (Jasanoff, 1990), concerned with the projection, measurement and monitoring of policy performance. While the science and politics of climate change may seem farther apart than ever, they are also intertwining in new and consequential ways. We are arguably on the cusp of a fundamental realignment of the relationship and the boundaries between international climate science and policy, crystallizing the move from climate science as a herald of societal problems and an advocate of political action, to a solution- and future-oriented regulatory science (Hajer & Pelzer, 2018).

Adapting to the post-Paris political terrain will thus see new forms of boundary work at different levels within and around the IPCC: At the cognitive level, creating distinctions between facts and values in the handling of proposed "solutions" will be challenging. This will raise new sociopolitical questions about the inclusion of different forms of expertise and about the right to frame the terms of assessments, as well as spatial questions concerning the representation of problems and solutions at various scales and according to the unique environmental and political contexts of different places. While our classification of boundary work into cognitive, sociopolitical, and spatial levels is used here as a heuristic to navigate an emerging body of literature, these conceptual distinctions should not be confused with or reified as real-world boundaries. In our analysis of the boundary work of the IPCC in the past and the future and in response to internal and external challenges, we can see how boundary work at one level has implications at other levels: Boundary work at the cognitive level may affect the allocation of power and responsibilities at the sociopolitical and result in new reconfigurations at the spatial level. This section builds on the last to explore how IPCC boundary work may be impacted by challenges that the organization may face in a post-Paris climate change policy landscape. Next, we use a recent debate over the science and politics of NETs (see Box 1) as a way into thinking about these shifting boundaries, and to anticipate the forms of boundary work which will likely emerge in response.

BOX 1

REPRESENTATIVE CONCENTRATION PATHWAYS AND NETS

Following IPCC AR4, a new set of climate scenarios were developed to inform subsequent assessments. A new set of Representative Concentration Pathways (RCPs) were produced. The RCPs removed the SRES's primary focus on social change and replaced it with a focus on a physical variable—radiative forcing—while also focusing on the end point of social change (radiative forcing levels in 2100), rather than plotting a path forward from the present (Oreskes, 2015). The RCPs provided a set of end points against which more detailed scenarios have since been developed, and against which climate policy options can be assessed for their effects on the likelihood of reaching certain goals. From the outset, controversy existed over the inclusion of a very low stabilization pathway—RCP2.6—and its reliance on NETs such as bioenergy with carbon capture and storage (BECCS), which are not yet available at the scale assumed in IAMs. The inclusion of this pathway was driven by concerns to keep the possibility space for policy-makers as open as possible (Edenhofer & Kowarsch, 2015), but others have criticized the relative opacity of the underlying assumptions, concerning both the technical and political, real-world feasibility of a massive BECCS roll-out (eg, Anderson, 2015; Rayner, 2016). Overoptimistic feasibility assessments have been a source of great controversy since the Paris Agreement was signed (European Academies Science Advisory Council [EASAC], 2018). We interpret this controversy as a struggle over the "performativity" of models and scenarios—their role in shaping political decision space, and in setting in train technological pathways which may not enjoy societal consent (Beck & Mahony, 2017).

4.1 | Shifting boundaries: Cognitive

The RCP/NETs/BECCS controversy provides new evidence of how science–policy boundaries are shifting on the cognitive level.

Soon after AR4, it was decided that the new scenarios should not be produced by the IPCC itself, as was the case for the SRES scenarios (Nakicenovic et al., 2000), but rather that the IPCC should essentially commission the Integrated Assessment Model (IAM) community to produce scenarios according to particular requirements (25th Session, April 2006). This was considered important in maintaining the distinction between scenario development and assessment, and therefore to maintaining the IPCC's independence as an assessor, rather than a producer, of knowledge (Beck & Mahony, 2018). As such, the episode provides a further glimpse into how the IPCC has maintained the external-facing boundaries between neutrality, relevance, and prescription through internal reorganizations and boundary work; here, in the effort to separate scenario development from assessment, and also in positioning a physical variable (radiative forcing) as the starting point of scenario development, as opposed to social variables and futures (Beck & Mahony, 2018; Oreskes, 2015).

The SRES–RCP shift arguably created the space for more speculative technological futures to find their way into officially authorized scenarios—one might ask the question of whether a technology like BECCS, a dominant carbon dioxide removal technology in IAMs, would have been included in the SRES scenarios given the SRES emphasis on social plausibility. We would suggest not, and that the move to the RCP methodology, which was partly a strategy of further distancing the IPCC from the messy business of socioeconomic scenario building, paradoxically facilitated the construction of futures which were both more speculative and politically charged than the SRES scenarios ever were. Technical feasibility and experimental reproducibility replaced social plausibility as the key criteria for formally sanctioning certain constructions of the future. As a result, such models routinely integrate the (highly speculative) assumption that technologies will be available by the latter part of the twenty-first century that remove more CO2 from the atmosphere than that added (Anderson, 2015; Anderson & Peters, 2016; Fridahl, 2017; Fuss et al., 2014; Himmelsbach, 2017). At the same time, the vision of "overshooting" emissions targets before pulling greenhouse gases out of the atmosphere has major political impacts and implications because it shifts the burden for mitigation from present to future generations and thus favors the high emitting countries in the current generation since they are required to do less in the near term (Preston, 2016, pp. xix-xx).

The EASAC warns:

> Placing an unrealistic expectation on such technologies could thus have irreversibly damaging consequences on future generations in the event of them failing to deliver. This would be a moral hazard which would be the antithesis of sustainable development [21: iv].

The idea of technologically afforded overshoot and respite is beginning to affect policy discussions in concrete terms, even if the requisite technologies are still highly speculative (Beck & Mahony, 2017; Geden & Löschel, 2017).

Although the scientific community conducted sophisticated multi-scenario analyses to explore the implications of alternative climate policies (Hallegatte et al., 2016, p. 62), the political implications of RCP2.6 or of a widespread deployment of BECCS to meet the 2 °C global warming target have not yet been fully discussed. While BECCS may help us achieve 2 °C targets in the models, it would involve massive displacements of land and people, with global implications for food supply, land rights, and environmental justice. Impacts on land use, food security and investment costs, and the wider politics of developing new plantations and infrastructures, have not yet been assessed in a systematic way, or openly communicated to policymakers. In response to overoptimistic feasibility assessments, for example, regarding deployment of CO_2 removal, more cautious reflections are emerging on IAM vs world real-world feasibility (eg, Rogelj et al., 2015).

A future IPCC may well be asked to help widen or at least communicate this engagement with the socioenvironmental complexities of technologies like BECCS. The IPCC, in its current configuration (see Hughes & Paterson, 2017), can do little more than treat options like BECCS as questions of technical feasibility within IAMs (Fuhr, 2017). This is a controversial situation, in which questions of technical feasibility and global economic efficiency have so far been given primary consideration over questions of social desirability or political legitimacy in the construction of actionable futures (Bellamy, Chilvers, & Vaughan, 2016). It demonstrates how a narrow scientific focus on "assessment," a product of boundary work at the cognitive level, can be instrumental in masking major political implications in terms of risks and responsibility, winners and losers, historical and future responsibilities, and the right to develop (Eckersley, 2017; Victor, 2015). Reflecting on the powerful position of IAM modelers in both scientific research into, and IPCC assessments of, mitigation options, Hughes & Paterson (2017, p. 20) conclude that:

> It is hard to continue to think of the IPCC as an organization that is merely producing assessments of the state of current knowledge—as an organization separate from the fields of knowledge production that it is charged with

> assessing. Through its authorship and authorization of the reports, the IPCC is defining both the terms of climate change mitigation knowledge production and global political action.

Some prominent IPCC figures have sought to navigate this slippage between research, assessment and policy by calling for a wider range of metric to be employed in assessing options like BECCS. Debate is required about how the IPCC could respond to the kind of "wider criteria" called for by Van Vuuren, Hof, Van Sluisveld, and Riahi (2017, p. 904):

> While IAM modelers typically assume that technologies are deployed on the basis of economic and technical considerations alone, BECCS in particular faces constraints with respect to societal support. The application of a wider set of criteria in model-based scenarios (other than those focusing on full cost optimization) and an exploration of scenarios with more pessimistic assumptions regarding the feasibility and public support for BECCS will allow for a more in-depth and constructive discussion of the relevant issues.

Others have likewise called for new modes of assessment which can take into account a fuller range of metrics for judging the suitability of such technological solutions (Beck & Mahony, 2017; Buck, 2016; Hajer & Pelzer, 2018; Parson, 2017). Wider sets of metrics are important; so too is reflection on the more tacit social and political judgments that underpin mitigation modeling (Jasanoff, 2004, p. 34; Hughes & Paterson, 2017). This may challenge existing boundaries drawn between different kinds of knowledge, between facts and values, between research and assessment, and particularly how different Working Groups of the IPCC conceive of such cognitive boundaries. If the IPCC is to become more solution-oriented (Lee, 2015), reflection on the location of these boundaries will be urgently required.

4.2 | Shifting boundaries: Sociopolitical

The way the IPCC has historically defined geoengineering provides an excellent example of boundary work at both the cognitive level and sociopolitical levels. In AR3, the definition of geoengineering included carbon capture and storage (CCS). With AR4, the IPCC excluded CCS from the geoengineering group of options, and normalized it into mitigation options. With AR5, BECCS was included in the category of mitigation, and thus excluded from the category of geoengineering. In order to enable the models to limit temperature rise below 2 °C, NETs were introduced toward the end of the century. IAMs in general and RCPs in particular have served to make NETS politically legible and actionable. IPCC performed an important legitimating function for the speculative technology of BECCS, pulling it into the political world, and making previously unthinkable notions—like overshoot and net zero emissions—more mainstream and acceptable, as well as perhaps pushing it ahead of alternative policy options (such as radical mitigation), and thus raising new questions about the neutrality of climate science (Beck & Mahony, 2018).[2] By drawing boundaries for ordering fields of research and governance, assessments serve as sites of de facto governance (Gupta & Möller, 2018): Understanding the political implications of this, particularly with regard to novel and speculative technological trajectories not yet subject to formal steering, remains a key task for social science scholars.

Haas argues that solution-oriented assessments (SOA) raise different challenges than global environmental assessments (GEAs) (Haas, 2017; van der Hel & Biermann, 2017), requiring explicit deliberation about values and political goals as well as technical policy responses to given issues. In this sense, SOAs differ from GEAs to the extent to which actors involved explicitly recognize SOAs as "more political" than GEAs (Haas, 2017; see also Victor, 2015; Stilgoe, 2017).

The RCP2.6 example demonstrates that the development of pathways is not simply about assessing scientific facts about the causes and trajectories of climate change. Projections of climate futures that provide the scientific ingredients of policy architectures are themselves based on, and products of, former political choices (Low, 2017). Pathways define the spectrum of political choices in the future by including options such as BECCS or excluding options such as nonovershoot pathways (Vervoort & Gupta, 2018). In this way, they are sites where future decisions about policy choices are anticipated and preempted, and perhaps prefigured. The link between the development of future pathways and political choices in the present is rarely understood and requires further exploration. In a solution-oriented mode, the IPCC will increasingly face difficult questions over how to handle the assessment of speculative and controversial technological "solutions." As work on the RCP2.6 example has shown, providing policy-relevant knowledge is a hybrid rather than a neutral activity, and experts must think of ways to combine scientific reasoning with social and political judgments—even when their formal role is to assess science (Jasanoff, 1990, p. 229; see also Haas, 2017; Victor, 2015). This is about more than widening the criteria by which technologies are evaluated. Research in STS suggests that being aware of the judgments made in research and assessment processes, and treating them as a matter of political choice (rather than black-boxing them) helps to open them up for change by exploring alternatives (Chilvers & Kearnes, 2015; Stirling, 2008; Wynne, 1993). If we accept this characterization, then it is clear that switching from a GEA to an SOA mode, even if the switch is gradual and uneven, will require new forms of boundary work as the IPCC seeks to rebalance scientific integrity and neutrality with political relevance and oversight.

4.3 | Shifting boundaries: Spatial

The broadening of the scope of SOAs arguably calls for a broader array of experts and stakeholders than do GEAs (Haas, 2017; Yamineva, 2017). Forms of cognitive boundary work (such as defining the task and scope of the assessment) often go hand in hand with forms of boundary work in the spatial and social-political dimension, including the questions of who counts as a credible expert and will be included in the organization (see Esguerra, Beck, & Lidskog, 2017). Different observers have asked whether calls for broader disciplinary and geopolitical participation can fit into a ponderous, centralized IPCC-style assessment or whether fundamental changes are required to the established and successful IPCC assessment process that has been in place since 1988—for example, nested and decentralized governance arrangements and open and flexible procedures to address particular knowledges and context-specific requirements. Debates over these questions in reference to the Intergovernmental Platform for Biodiversity and Ecosystem Services (IPBES) are instructive—having learned much from the IPCC experience, IPBES may now have lessons to send the other way (Borie & Hulme, 2015; Esguerra et al., 2017; Montana, 2017; Obermeister, 2017).

4.3.1 | Local and global

The tension between local and global scales of knowledge-making, and between different national regulatory science styles, has recently occupied the intersections of STS, human geography (Mahony, 2015; Mahony & Hulme, 2016), institutional theory and political ecology (Beck et al., 2016; Winickoff & Mondou, 2017). Leading IPCC representatives insist that demands for geopolitical balance have to be reconciled with scientific excellence and IPCC's scientific standards (Schiermeier & Tollefson, 2015). As discussed above, there can be a profound tension between the cognitive, sociopolitical and spatial aspects of boundary work. Questions of participation have commonly been restricted to questions of input-, process-, and output-legitimacy in the GEA and SOA literature, thereby ignoring their political impacts and the political contexts in which they are embedded (Haas, 2017; Minx, Lamb, Callaghan, Bornmann, & Fuss, 2017). Traditional approaches to GEAs underestimate questions of translation, power and representation (Klenk, Fiume, Meehan, & Gibbes, 2017). In recognition of the political power of the IPCC, developing countries have long stressed the need for equitable representation and participation (Agrawala, 1998). Power imbalances, biased representation and the lack of access and capacity are persistent challenges to international research and assessment platforms. These persistent problems highlight the importance of openly addressing questions of inclusion and representation, rather than only defending the ideal of neutral, aggregated and thus more balanced expertise (Hughes & Paterson, 2017). These challenges may rise in importance when it comes to debates about future pathways because they may affect citizens around the world in differentiated ways; these iniquities may be supplemented by the distributional consequences of the emerging technologies such as NETs or solar radiation management (see Flegal & Gupta, 2017; Stilgoe, 2015). While fitting neatly into calculations of global economic optimality in mitigation, technologies like NETs would be assessed very differently from the standpoint of local impacts and political contexts. Green NGOs such as ETC Group, formerly supportive of the work and findings of the IPCC, are starting to openly criticize the IPCC for integrating geoengineering into its reports and providing normalizing evidence for its feasibility and necessity (Fuhr, 2017).

4.3.2 | Coping with diversity

Incorporating increased epistemic and indeed geopolitical diversity into IPCC reports may further challenge the limits of consensus as the organizing principle of assessments—something which has increasingly occupied the minds of IPCC participants and observers (Beatty & Moore, 2010; Grundmann, 2007; Hulme, 2013; Kowarsch, Flachsland, Garard, Jabbour, & Riousset, 2017; Montana, 2017; Obermeister, 2017; Oppenheimer, O'Neill, Webster, & Agrawala, 2007; Pearce, Brown, Nerlich, & Koteyko, 2015; Pearce, Mahony, & Raman, 2018; Swart, Bernstein, Ha-Duong, & Petersen, 2009). Repeated controversies show that even when scientists, politicians and publics agree on basic principles such as the scientific evidence of global warming, there is still plenty of room for disagreement about what the implications of scientific findings are for action (see also Victor, 2015). Comparative studies show that disagreement is often rooted in more fundamental differences over world-making assumptions such as the boundaries of state interventions into the market; these controversies also reflect crucial political and normative disagreements about the role of science in policy-making (Jasanoff, 2011).

As the IPCC engages more closely with policy-driven questions and putative solutions, disagreement will increasingly be encountered in the scientific literature and among author teams. Pearce et al. (2018, p. 128) argue that "scientific advisory processes may benefit from acknowledging points of disagreement. Indeed, their role of knowledge appraisal, properly understood, calls for expanding the range of alternative policy options and clarifying what underlies them rather than prematurely closing down what is considered feasible or desirable" (see also Stirling, 2008). This is not to say that science forces convergence on solutions, because two domains of representation (epistemic and political) are automatically conflated within a singular "world" of intertwined science and policy (see Sundqvist et al., 2017). Rather, it signals the challenge of coping with diverse modes of representation. While formalizing its rules of procedures, the IPCC also developed the strategy of "agreeing

to disagree," thus readapting and applying them (such as in uncertainty communication) according to context-specific needs (Swart et al., 2009). These forms of institutional and organizational diversity (Montana, 2017; Obermeister, 2017) and respective forms of boundary work at the spatial and sociopolitical level indicate a capacity for institutional reflexivity which will be increasingly important into the future. The IPCC's recent emphasis on clarifying areas of disagreement offers potential for a broader opening-up of not just cognitive disagreement, but sociopolitical and spatial complexity too.

4.4 | Shifting societal contexts and external challenges

In this section, we explore the shifting external contexts in which the IPCC is embedded, and discuss implications of this broader context for revisiting assessment design and reflecting on the future role of the IPCC in climate policy-making. In order to link the discussion on future challenge to the previous discussions, we continue to review the state of discussion through our framework of cognitive, sociopolitical, and spatial dimensions of boundary work. We thereby explore how our framework helps illuminate particular aspects of present challenges, and how they might be mediated.

4.4.1 | Polycentric governance? Sociopolitical and spatial challenges

STS and IR approaches to boundary work ask how organizations are responsive to changing political contexts—such as the emerging climate regime. COP21 represents a major change in the climate regime. After COP21, the IPCC has to adapt to the pluralistic political architecture of the Paris Agreement and to become more responsive to the needs of state and nonstate actors at different levels of decision-making (Barben, 2007; Devès, Lang, Bourrelier, & Valérian, 2018). When the IPCC was formed in 1988 it fitted neatly into the UN's multilateral order of centralized governance regime based on national representation and the search for internationally negotiated solutions (Eckersley, 2012). The Paris agreement, however, adopts an essentially voluntary, decentralized climate policy architecture which has important implications for how we think about the relationship between science and politics (Aykut, 2016; Aykut, Foyer, & Morena, 2017; Geden, 2016).We shouldn't necessarily take the Paris regime's polycentricity for granted and risk obscuring apparent international convergence on (a) the fact that climate change is happening, and (b) business-as-usual can largely continue despite face-value commitments to the contrary.[3] Amidst this potential disjoint between the rhetoric and reality of policy commitments, outstanding technical questions about the monitoring and reporting of policy performance, which are essential for the compliance and enforcement within the climate regime, become even more urgent for the climate science community to address (Dooley & Gupta, 2017; Gupta, Lövbrand, Turnhout, & Vijge, 2012; Schoenefeld, Hildén, & Jordan, 2016; Turnhout et al., 2017). There are broader questions too as to whether the "audience" and "owners" of IPCC assessments should continue to just be nation-state parties to the UNFCCC, or whether the IPCC should be more directly accountable to the broader set of (nonstate) actors such as the local and regional authorities, civil society groups and private companies that now participate actively in the governance of climate (Kuyper, Bäckstrand, & Schroeder, 2017). Due to its intergovernmental status, the IPCC defines public engagement as a task of nation states. The Paris Agreement and its decentralized architectures may entail some boundary work in terms of the rearrangement of interactions between the IPCC and publics at different levels of decision-making. This implies an opening up of perceptual horizons to recognize different models of "ownership" (state/nonstate/UN) and to legitimize multiple knowledges and diverse standards of evaluation (see Endfield & Morris, 2012).

Less has been explicitly said about the role of science in what political scientists and geographers would call polycentric or fragmented governance regimes (Ostrom, 2014). Indeed, regulatory approaches to global issues, from climate change to food safety, are increasingly operating through pluralistic, overlapping, and fragmented regimes (Abbott, 2012; Compagnon & Bernstein, 2017; Keohane & Victor, 2011; Kuyper et al., 2017). While embraced by some as being more attuned to local contexts (Ostrom, 2014), they introduce different sorts of political problems: Regulatory complexity can result in overlap and competition across multiple dimensions. As jurisdictional integrity and sovereignty shift along these dimensions, the balance of power among multiple levels and across the public and private sector has also shifted. Complex and nested-network models of governance are of interest because they help focus on the role of science in particular kinds of changes in global governance, especially processes of decentralization and centralization, and of public-private hybridization (Eckersley, 2017; Kuyper et al., 2017; Zürn, 2017).

In an increasingly complex post-Kyoto landscape, the IPCC has to respond to distributed governance structures. Thus, what role can the IPCC play in the post-Kyoto, post-Paris regime and how can it contribute to a fragmented climate governance order? (van der Hel & Biermann, 2017; Yamineva, 2017). Social science scholars have started to show how these processes may depend upon, more than has been acknowledged, the production of new forms of science and expertise. In U.S. climate policy and implementation, for instance, it has been shown that federalist power struggles get resolved on the terrain of regulatory science and the assignment of "epistemic jurisdiction" (Winickoff & Mondou, 2017). Science and multilevel governance is also a key theme in the study of the European Union: Jurisdictional tensions around the operation of risk assessment may embody tacit or explicit constitutional ordering principles and override deeply seated and institutionalized modes of

public reasoning (Jasanoff, 2011) rather than create spaces for the protection of local values and local autonomy. This work tends to recast the problem of authority in federal governance regimes such as the European Union as a problem of "epistemic subsidiarity" (Laurent, 2016; Jasanoff, 2013), drawing out the question of how "the local" and "the global" do and should interact in processes of making knowledge. IPBES, for instance, is experimenting with a decentralized and nested approach to stakeholder engagement, which is thought to provide scientifically robust knowledge that is also responsive to local context-specific needs (Esguerra et al., 2017).

4.4.2 | "Post-truth" politics and cognitive boundaries

Recent anxieties about the emergence of a so-called "post-truth" politics touch upon what some see as the erosion of the in-built relationship between science and liberal democracy. The IPCC has been exposed to public scrutiny since its beginnings. By the end of the 1980s, lobby groups from the oil and car industries (mainly in the United States) formed a coalition and began to attack the IPCC, in a pattern repeated in the media in response to controversies with the SAR and in the aftermath of "Climategate" and COP 15 in 2009 (see Oreskes & Conway, 2010; Pearce, 2010; Vardy, Oppenheimer, Dubash, O'Reilly, & Jamieson, 2017). Given its political significance, the IPCC may also become the lightning rod to an increasingly partisan politics in a highly politicized public context, especially in the United States and United Kingdom (Jasanoff, 2017; Jasanoff & Simmet, 2017; Lynch, 2017; Sismondo, 2017a, 2017b). A strand of research attributes the IPCC's occasional credibility problems to the corruption of science by political interests (IAC, 2010; Oreskes & Conway, 2010; Lewandowsky, Oreskes, Risbey, Newell, & Smithson, 2015). In a similar way, the IPCC frames trust as a function of technical communication, based on the assumption that more and better consensual science and communication will result in political action. The reluctant responses of the IPCC establishment to openly address public scrutiny and its poor performance after "Climategate," however, have arguably contributed toward exacerbating the problem of trust, despite the scientific quality of the IPCC reports being seriously challenged (Beck, 2012b). As responses to the "Climategate" affair show, public trust in the IPCC is not simply based on pure, scientific consensus, but also related to the performance and persuasive power of the people and institutions who speak for science (Hajer, 2009, 2012; Hughes, 2015) and to deeply embedded styles of evaluating knowledge claims in the public sphere (Beck, 2012b; Jasanoff, 2011). It is an open question whether and how emerging right-wing populism and attacks on climate science will interact with and affect the workings and public performance of the IPCC (Vardy et al., 2017). It nonetheless raises questions about the procedures, practices, and levels of formalization that undergird the Panel's authority claims, and through which it interacts with, and performs in front of, a diversity of audiences and publics (Jasanoff & Simmet, 2017).

These challenges indicate the mutual co-production of epistemic and political authority (Bremer & Meisch, 2017). Climate change is a totemic example of where science is asked to provide evidence for "inconvenient" political decisions and where expertise has become a major source of political legitimation. Expertise is thereby also used to address problems of missing political legitimacy—such as deficits of democratic legitimation of supra-national institutions—and of political consent—such as how to achieve far-reaching climate targets in complex fields such as transport. The growing political demand for legitimation by experts for political choices raises novel challenges for science and expert bodies; responding carefully to them will avoid any further undermining of their integrity and trust in the long-term. More work is required to explore links between forms of scientific and political representation (Eckersley, 2017).

These examples have shown that boundary work (at the cognitive level) can also shape boundary work at the sociopolitical and spatial level and thus the design of institutional arrangements. Boundary work is not a neutral but a performative practice. As a consequence, some scholars have drawn attention to framing effects, their "political implications" and "cognitive lock-in" to particular options and future pathways (Chilvers & Kearnes, 2015; Hulme, 2010). Jasanoff has shown that cognitive boundary work has political implications in terms of who belongs within expert collectives and hence is entitled to speak for it, as well as who does not belong and hence lacks such authority at the sociopolitical and spatial level (Jasanoff, 1990). Framing what counts as a scientific matter and thus is included into the scientific agenda at the cognitive level helps to specify who gets to participate in defining which knowledge matters, and thus to constrain or enable the agency of different actors. For example, a narrow framing of climate change as a purely technical issue reduces the role of stakeholders to one of trusting or distrusting experts, leaving little room for deeper engagement (Lidskog & Sundqvist, 2015).

Boundary work also contributes to enabling different kinds of institutional arrangements. The definition of categories such as who speaks for science and for stakeholders (boundary work at the cognitive level) greatly influences how stakeholders are "invited" and how rules of procedure are set up to guide the work of an organization (including membership, tasks, and accountabilities) (Chilvers & Kearnes, 2015; Wynne, 2002).

Together, these challenges show the need for ongoing reflection on the role of climate science in general, and the IPCC in particular, in society and politics.

5 | CONCLUSION

In this review, we have sketched-out the history and future prospects of boundary work in and around the IPCC, suggesting three different but interacting levels or modes of boundary work—cognitive, sociopolitical, and spatial. Disaggregating these distinct modes of boundary work helps us to see not only the contested processes by which GEAs negotiate the science/politics boundary, but also the broader effects of these processes for the politics of an issue like climate change. We have used this framework and recent controversies to anticipate what operating in a solution-oriented mode might mean for the IPCC, within the context of a post-Paris realignment of climate science and policy, an emerging polycentricity in climate governance, and broader concerns about the place of truth and expertise in public life.

The turn toward future solutions will likely generate novel challenges for the IPCC—such as addressing the fact-value-dimension in a more explicit way and coping with value-laden questions at the cognitive level, as well as the inclusion of a broader range of actors (at the sociopolitical level), each with different epistemic, ethical and political commitments (Kowarsch et al., 2017). Coping with these challenges will demand a new form of reflexivity to critically self-examine (and thus render open to change) the institution's own performance and basic assumptions in the light of novel demands, and how procedures and governance structures can be adjusted in response to scientific developments and to transformations in the societal context. Elsewhere we have drawn on the literature on responsible research and innovation (eg, Bellamy et al., 2016; Stilgoe, 2015) and proposed "responsible assessment" as a mode of meeting this reflexivity challenge when it comes to the assessment of controversial issues like geoengineering and NETs (Beck & Mahony, 2018). The IPCC is an incredibly powerful actor in climate politics. It is an important player in making futures, not just forecasting them—in putting certain options on the table, while potentially obscuring others. This role is likely to intensify in a new solution-oriented mode. By taking responsibility for this role, the IPCC can continue to exercise its political power wisely, by keeping the possibility space of political action open for negotiation among a diversity of actors and options.

ACKNOWLEDGMENTS

This work was funded by the German DFG in the context of the Priority Program Climate Engineering: Risks, Challenges, Opportunities (SPP 1689), and by the University of Nottingham International Collaboration Fund.

CONFLICT OF INTEREST

The authors have declared no conflicts of interest for this article.

ENDNOTES

[1]Thanks to reviewer 2 for this observation.

[2]https://www.icsu.org/current/blog/why-the-ipccs-upcoming-1-5c-report-offers-an-unexpected-glimpse-of-hope

[3]Thanks to reviewer 2 for making this point.

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Martin Mahony http://orcid.org/0000-0002-6377-413X

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How to cite this article: Beck S, Mahony M. The IPCC and the new map of science and politics. *WIREs Clim Change*. 2018;e547. https://doi.org/10.1002/wcc.547