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Impact of scientific research on the international climate regime: the strategic niche of the emissions gap reports

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In the Paris Climate Agreement of 2015, countries agreed to a two-track approach to emissions and climate targets. For emissions they agreed to voluntary national emission reduction commitments (pledges), and for climate, to hold global temperature increases to “well below 2°C above pre-industrial levels” with a major effort to “limit the temperature increase to 1.5°C.” But the Agreement does not address the possible disconnect between these two tracks nor answer the question: When summed together, are national commitments for reducing emissions sufficient for staying within the agreed-upon global temperature limits? In order to address this question, and fill an important niche in the climate regime, the Emissions Gap report series presents an annual analysis of the discrepancy between pledges to reduce national emissions and agreed-upon temperature limits. In this paper we use an established framework to assess the impacts of the report series. An example of its impact is that data and findings from the report have been used for several years by country delegations to Climate COPs to inform and/or justify national policies to reduce or limit greenhouse gas emissions. We conjecture that several factors contribute to the impacts of the report series. For example, it appears to provide an accepted neutral playing field for debating the sufficiency of national emissions commitments to meeting global temperature targets. Other factors include its timeliness in addressing a key international policy question, its contribution to framing the policy of “ambition-raising and stocktaking,” its impartial synthesis of results from many different scientific groups and high scientific quality, its usefulness as an awareness-raising tool, and its production by a major, credible international boundary organisation (UNEP), among other factors. In general, the Emissions Gap report series shows that research findings, if strategically targeted and presented, can fill an important information niche in the policy landscape and have a tangible positive influence on climate policymaking. Yet after all this, its ultimate impact is certainly more modest since after several report editions, the emissions gap remains wide.

KEYWORDS

international climate regime, emissions gap reports, Paris climate agreement, global greenhouse gas emissions, global temperature limits, climate change, emissions reductions, emissions gap

1 Introduction and background

The “international climate regime” is the term given to the procedures, actions, and rules used to enact international climate policymaking (Pattberg and Widerberg, 2017). Within this complex of policymaking many different forces exert their influence. Among these is scientific research which wields impact through the reports of the Intergovernmental Panel on Climate Change, the debates at the Subsidiary Body of Science and Technology under the UN Framework Convention on Climate Change, the documents of national climate advisory groups, and other routes.

This paper describes a unique example of how scientific research influences the international climate regime through the Emissions Gap report series, produced annually since 2010 by the United Nations Environment Programme (UNEP, 2024a; UNEP, 2024b). These documents address a key question of international climate policy—When summed together, are national commitments for reducing emissions sufficient for staying within accepted global temperature limits?

The objectives of this paper are to describe and present evidence of the impacts of the Emissions Gap reports, elucidate how these impacts were achieved, and reflect on lessons learned.

The setting of the Emissions Gap reports dates back to the early 2000s as international negotiations progressed towards a major new international climate treaty. But progress was stymied at the 2009 Climate Conference of Parties (COP 15) in Copenhagen particularly because key countries refused to agree to binding targets for emissions. Recovering from the setback in Copenhagen, two important developments occurred at the next COP in Cancun. First, countries agreed to a goal for limiting atmospheric temperature increases to 2°C above pre-industrial, and to 1.5°C “if possible.” Second, a number of countries put forward voluntary mitigation commitments that were formalised as the “Cancun Pledges” and became an alternative to binding targets. But there was a disconnect between these two developments: When added up, would the pledges be sufficient to stay within the 2°/1.5°C limits?

Negotiations towards a global agreement got back on track in 2011 when COP 17 in Durban agreed to a new negotiation framework that side-stepped binding targets. Ultimately, in the Paris Climate Agreement of 2015, countries agreed to a two-track approach to emissions and climate targets. For emissions they agreed in Article 4.2 to nationally determined emission reduction commitments (pledges), as well as a global emissions target that would lead to a zero balance between emissions and sources of greenhouse gases in the second half of the 21st century. For climate they confirmed the Cancun limit by agreeing in Article 2.1a to hold global temperature increases to “well below 2°C above pre-industrial levels” with a major effort to “limit the temperature increase to 1.5°C” (UNFCCC, 2015a).

But the disconnect raised at COP 16 in Cancun raised its head again here—How would parties know if national emission reduction commitments, when added up, were sufficient to stay within specified temperature limits? The success of the new international climate regime depended on getting an answer to this question. The approach Paris negotiators agreed to (Article 14) was to set up a five-year “ambition-raising cycle” which called on countries to continuously strengthen their mitigation pledges. It was agreed to conclude each five-year cycle with a “global stocktake” to assess collective progress towards achieving the goals of the Paris Agreement, counting on

public and international pressure to motivate necessary mitigation actions. But the long interval between stocktakes and the unspecified nature of these stocktakes created a niche in the climate regime for a concrete process or product that could regularly inform Parties to the Paris Agreement on whether current global emission trends were sufficient for staying within temperature limits. Filling this niche is the UNEP Emissions Gap report series.

At the core of an Emissions Gap report is a “gap analysis”—a comparison of two types of global emissions scenarios: One type depicts emission trends expected under current mitigation pledges and the other depicts emission trends that stay within limits to global temperature increases (1. and 2.0°C; Figure 1; in the context of the Paris Agreement, current mitigation pledges are called “nationally determined contributions”). The difference in emissions between the two is characterised as “the gap.” The size of the gap indicates the size of the disconnect between pledges and emission levels consistent with temperature limits. If there is no gap, then in principle, current emission commitments are sufficient for staying within temperature limits. If there is a gap, then current commitments are insufficient.

Most scenarios used in the gap analysis are produced by integrated assessment models, with a few by other means. According to the Integrated Assessment Modelling Consortium “Integrated assessment models” (IAMs) are simplified representations of complex physical and social systems, focusing on the interaction between economy, society and the environment (IAMC, 2024). IAMs were first widely used to analyse European-scale acid rain and transboundary air pollution in the 1980s (Dowlatabadi, 1995), and are now frequently used to address science-policy questions having to do with climate change.

From the outset, Gap reports have presented an ensemble of scenario estimates from a wide range of models and modelling groups, rather than from a single model or group. Since the reports were initiated, results from at least five different IAM research groups have been included in the gap analysis. We believe the presentation of a range of views heightened the legitimacy of the reports.

The first Emissions Gap report was issued in 2010 (UNEP, 2010a). Beginning the following year, the reports included not only the gap analysis, but also a large section on policies and measures for closing the gap. For example the 2012 report included estimates of potential emission reductions in various economic sectors. In this way the reports not only alerted policymakers to a problem (the gap) but also offered solutions. We believe this balanced approach enhanced the credibility of the reports.

Estimates of emission reduction potentials by sector were updated annually until 2016. A rigorous new assessment was included in the 2017 report, which was cited extensively, including by the Intergovernmental Panel on Climate Change in its Sixth Assessment Report. An updated assessment of sectoral emission reduction potentials by various years is included in the 2024 edition of the report.

2 The impact of the reports

2.1 Methodology for evaluating impact

Evaluating the impact of research is not an easy task. Occasionally a direct line can be traced between research and policy, as in the case of the indisputable influence of research on international policy to

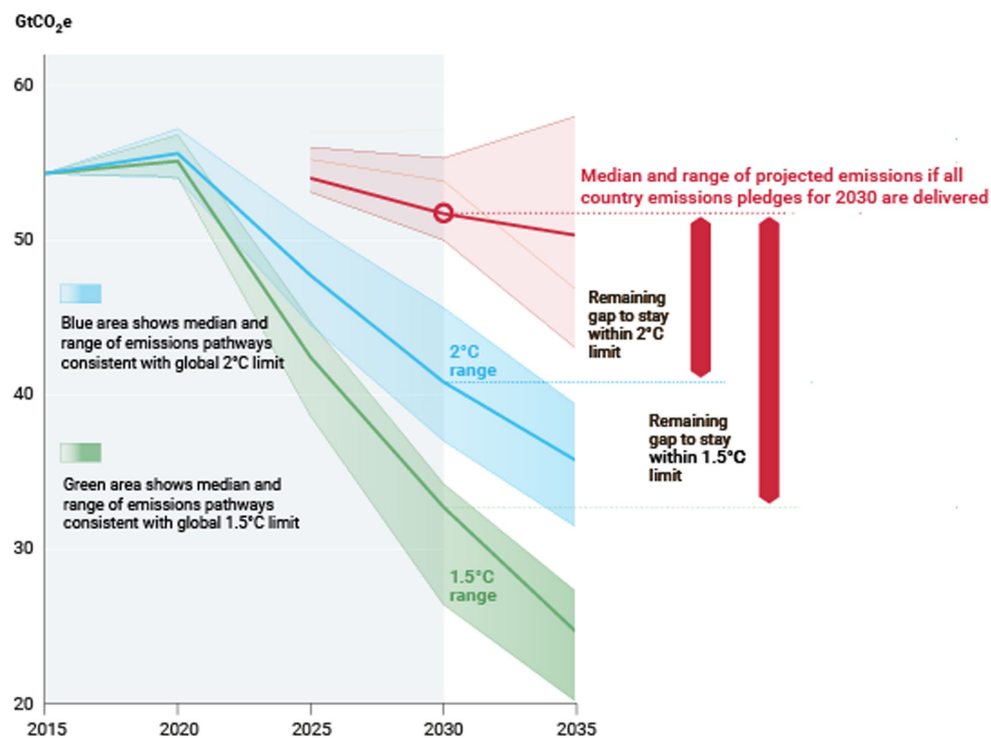


FIGURE 1

Illustration of emissions gap for 2030. Red area shows expected global emissions if current (2023) country pledges are delivered. Blue area shows pathways limiting global temperature increase to below 2°C (with about a 66% chance). Green area shows pathways limiting global temperature increase to below 1.5°C (with a 50% chance by 2,100 and minimum 33% chance over the course of the century). The “emissions gap” in 2030 to stay below 2°C is the difference between the red and blue areas. The gap to stay below 1.5°C is the difference between the red and green areas (explanation of blue and green areas taken from Emissions Gap 2024 report).

protect the ozone layer (Solomon et al., 2020). But this is the exception rather than the rule, and this uncertainty has led to a more flexible definition of research impact including indirect influences (Loudner et al., 2021; Reed et al., 2021), as discussed below. We agree with this more flexible approach and therefore use the impact evaluation framework of Edwards and Meagher (2020) which is consistent with this view. The framework (Supplementary Table S-1) consists of an ordered set of questions that helps evaluators articulate the policy impact of the research in question, clarify the causes of impact, and elucidate lessons from the evaluation.

2.2 Instrumental impact

The first type of impact we examine is “instrumental impact” which refers to a tangible change in plans, decisions, behaviours, practices, actions, or policies caused by a body of research (Edwards and Meagher, 2020). These are the traceable direct impacts of research and also the most difficult to attribute.

The main target group of the reports are country delegations to the annual Climate COPs. This has been a conscious strategic decision because the COPs are usually the most important annual event for advancing international climate policy. Since 2016, annual surveys have been undertaken to assess the extent to which country delegations are aware of, have read, and/or have used the Emissions Gap reports in climate negotiations and as part of their preparation of their submissions to the UNFCCC. (Table 1) (No survey was carried

out in 2020 because the COP was cancelled due to the COVID pandemic.) According to these surveys 50 to 85% of national delegate respondents used the report during negotiations, 26 to 63% used the report for preparing new or updated national mitigation pledges, and 63 to 93% scored the usefulness of the report as 8 or higher on a scale of 1 to 10. The survey, however, only reached a subset of all delegates (a high of 82 respondents and a low of 12).

Another example of direct impact of the report is the fact that since 2020 UN Secretary General António Guterres has used the annual launch of the Emissions Gap reports to widely convey the urgency of reducing global greenhouse gas emissions (e.g., UN Secretary General, 2020).

There is also evidence that the Emissions Gap reports have encouraged further international reporting of the gap. For example, since the reports were initiated, the IPCC has devoted extensive sections in its reports to the gap (e.g., IPCC, 2014; IPCC, 2023).

It is more difficult to track a direct path between the reports and national policy processes because of the complexity of these processes and because they are usually poorly documented. Impact of this sort could be investigated by surveying officials working in national governments, but this was outside the scope of this paper. Nevertheless, the above survey results suggest impact at the national level since 26 to 72% of respondents said that the reports had been used as input to the setting of new national emission reduction pledges. Also, findings from the report are frequently used in opening statements of national governments and groupings of countries at the annual Conference of Parties to support their

TABLE 1 Results of survey of national climate delegates at Climate Conferences of Parties on use of Emissions Gap Report.

	Emissions Gap Report survey results						
	2023	2022	2021	2019	2018	2017	2016
No. of respondents	12	15	82	52	35	40	45
Percentage of national delegate respondents indicating that the report was used during negotiations	75	85	77	56	50	50	68
Percentage of national delegate respondents indicating that the report was used for the preparation of their new or updated mitigation pledges (nationally determined contributions)	63	69	72	53	47	29	26
Percentage of respondents scoring the report at 8 or higher in terms of usefulness (on a scale of 1–10)	60	93	82	56	70	74	63

Source: United Nations Environment Report, unpublished survey results.

climate policies [e.g., Gambia for the “Least developed countries” group at COP 18; [Gambia Government on behalf of the Least Developed Countries \(LDCs\), 2012](#)]. Further evidence of influence is found in national climate policy statements at COPs that utilise Emissions Gap results to frame national policies (e.g., [French Government, 2021](#); [Australian Government, 2022](#); [UK Parliament, 2023](#)).

In all of these cases data and findings from Emissions Gap reports were directly used to inform and/or justify national or international policies to reduce or limit greenhouse gas emissions. The reports, and the scientific analysis behind them, appear to provide an accepted neutral playing field for debating the sufficiency of national emissions commitments to meeting global temperature targets. In this way they have contributed directly to the “ambition-raising and stocktaking” aim of the Paris Agreement ([UNFCCC, 2024a](#)).

To relativise these findings, we note that the implicit aim of the authors of the Emissions Gap report series is to narrow or even close the emissions gap. But lacking a counterfactual analysis, we cannot ascertain if the report series has contributed to a narrowing of the gap or not. Certainly its ultimate impact up to now has been insufficient since the gap is still large ([Figure 1](#)), and has even widened according to some analyses ([Höhne et al., 2020](#)).

2.3 Conceptual impact

“Conceptual impact” refers to changes to awareness, knowledge, attitudes, or emotions caused by a body of research ([Edwards and Meagher, 2020](#)). The Emissions Gap reports have been an effective instrument for raising awareness about key climate policy issues. Beginning with the first report ([UNEP, 2010a](#)) they have compared results from several studies in a consistent fashion and brought clarity to the meaning and size of the emissions gap.

Many different routes have been used to raise awareness. An important route has been the numerous briefings on report findings requested by climate delegations and officials, and the significant number of invited presentations at key UNFCCC events. These have included presentations to the European Parliament delegation at Climate COP 18 in 2012, to the plenary of SBSTA (The UN FCCC Subsidiary Body for Scientific and Technological Advice) in 2013, to the Structured Expert Dialogues between 2013 and 2015 ([UNFCCC, 2015b](#)), the Talanoa Dialogue in 2018, the European Parliament and the Office of the US Special Presidential Envoy for Climate in 2024, as some examples.

Another route has been through extensive international and national media coverage. Since 2015, media coverage within the first 24 h of the reports’ release has been around 2000 articles published in approximately 1,500 outlets across more than 80 countries and in about 25 languages ([Olhoff, 2025](#)).

2.4 Other impacts

The evaluation framework of [Edwards and Meagher \(2020\)](#) suggests other routes to research impact. For example they refer to “enduring connectivity” meaning the positive impact of research achieved by initiating a long term mutually beneficial relationship between researchers and users of research. In the case of the Emissions Gap reports, since 2010 many researchers and research groups have found an important outlet for their modelling and analyses in the reports and are assured that their work will come to the attention of important policymakers. Likewise policymakers have confidence that an annual report will be available to them that provides a global perspective on the emissions gap ([UNFCCC, 2015a](#)).

3 How were impacts achieved?

How did the Emissions Gap reports become influential? To discuss this we use the framework of [Edwards and Meagher \(2020\)](#) who assert that research achieves impact through contextual factors, design for user needs (“input and output”), problem framing, research management, dissemination, and engagement.

3.1 Contextual factors

Perhaps the simplest explanation of the impact of the Emissions Gap report series is that it appeared at the right time and right place. As noted above, the Paris Climate Agreement formalised emission pledges and temperature limits but provided only a vague process to assess whether the pledges are adequate to stay within temperature limits. The Emissions Gap reports filled this important niche and were embraced by countries as a vehicle for debating the adequacy of pledges. The reports were already available when the notion of “ambition-raising and stocktaking” was only a

background theme to climate negotiations and they helped to make this policy feasible when it was formalised in the Paris Agreement in 2015.

3.2 Design for user needs

Although the Emissions Gap reports had a strong political context, this did not guarantee their uptake by political actors. We believe other factors played a role here, particularly the way the reports were designed (termed “Inputs and Outputs” by Edwards and Meagher, 2020). For example:

- The report condenses complex scientific issues into simple/understandable and policy-relevant questions. The language of the report is kept relatively non-technical and comprehensible, and the overall design of the report is meant to be attractive to readers.
- Despite the complexity of the analyses, the main result of the report can be conveyed in a single number—the gap in emissions at a reference point in the future. For example, UNEP briefings on the 2012 report reported that gap “is 42 Gt equivalent-CO₂/yr in 2030, approximately equivalent to the emissions from all OECD countries in 2010.” This simplicity is at the same time also a weakness, because countries can point to all other countries as being responsible for the gap. The reports thus far have shied away from the alternative approach of recommending what individual countries should do to close the gap, from an equity perspective. This omission has weakened the impact of the reports by making them less relevant to individual countries, but also maintained their acceptance by others.
- Data presented in the reports are from several scientific groups rather than a single group. The comparison of different modelling analyses requires reconciling and harmonizing methodological differences (e.g., differing cut-off dates; different approaches to inclusion of forestry emissions or international transport). However, we believe this pluralistic approach enhances the credibility of the report, as does the presentation of the uncertainty range resulting from the different modelling estimates. Furthermore, this differentiates the Emissions Gap report series from the “Synthesis Report” that is mandated by the parties to the Paris Climate Convention (UNFCCC, 2024b). The Synthesis Report includes a similar annual analysis, but only draws on information provided by national governments.
- The reports present not only an analysis of a problem (the emissions gap) but also solutions that can be taken up by climate policymakers. But the solutions are more complex than the description of the emissions gap. For solutions to be effective and actionable, they need to be differentiated by region and/or country but this is outside the scope of the Emissions Gap report series. In addition, the reports do not elaborate on the underlying drivers for the gap, including economic and political factors and consumption patterns.
- The reports are published annually and therefore complement the 6 to 7 years cycle of the main reports of the Intergovernmental Panel on Climate Change which cover some of the same material,

and the 5 years cycle of the official “stocktaking” under the UN FCCC.

3.3 Problem framing

Framing a problem, and having it accepted by influential policymakers, is another important route to impact (Edwards and Meagher, 2020). Hoppe et al. (2013) point out that scientists have a particular opportunity to help frame a problem in the early stages of public issue definition, before multiple actors begin to vie for influence. This was the case for the Emissions Gap reports. While the idea of “ambition-raising and stocktaking” was taking shape in the climate negotiations around 2010, it was climate modellers that offered the lucid narrative that there was a “gap” between the emission pathways needed for staying within temperature limits and policy pledges. This “gap” formulation stemmed from published work on emission scenarios in the literature (e.g., den Elzen et al., 2007; Meinshausen et al., 2009; others) which was then introduced to a wide policy audience through the Emissions Gap reports, and ultimately taken up by climate negotiators. The concept of the emissions gap is now an established term.

3.4 Research management—boundary organisations

Researchers have asserted that “boundary organisations” often play a decisive role as conduits of science to policy, and vice versa. These are “social arrangements, networks, and institutions that increasingly mediate between the institutions of ‘science’ and the institutions of ‘politics’ (Guston, 1999; Miller, 2001). In the context of the Emissions Gap reports, the United Nations Environment Programme serves as a very prominent boundary organisation, providing a bridge between the science community engaged in integrated assessment modelling of climate change and the international climate policy community. Within UNEP, its Chief Scientist’ office, as well as its Climate Coordination Centre in Denmark, played particularly important roles in the first few years of the report.

According to Hoppe et al. (2013), boundary organisations perform their function through “double participation,” “dual accountability,” and by producing “boundary objects.”

“Double participation” refers to the fact that people from both policy and science are represented in the organisation. With regards to UNEP, while its professionals primarily do policy work, many have scientific training and experience. Also, external scientists are engaged with UNEP as report authors and reviewers, and as members of scientific panels. Hence, although UNEP operates in the policy sphere, the science community is strongly present, and there is certainly “double participation” in both policy and science spheres.

At the initiation of the Emissions Gap reports “double participation” was particularly strong—The reports’ champion at UNEP was its Chief Scientist who served as Chair of the Steering Committee of the first five reports, and had a particular familiarity with integrated assessment modelling having contributed to its development and application to acid rain and climate change on the international level (Alcamo et al., 1985; Alcamo, 1994).

In a sense, the Office of the Chief Scientist served as a boundary institution within a larger boundary institution. The Chief Scientist also played an intermediary role in the lead-up to the reports, for example, by providing numerous briefings on the emissions gap and modelling results to international policymakers including ministers in the UNEP Governing Council in 2010 (UNEP, 2010b).

“Dual accountability,” according to Hoppe et al. (2013) refers to the accountability of management to representatives of both science and politics. UNEP is accountable to the science community through a system of scientific advisory panels and peer reviewers of publications, and to the policy community through its governance body, the United Nations Environment Assembly. This accountability provides challenges in report production. For example, UNEP has resisted pressure from its governance body to include more country-specific data in the Emissions Gap report series, arguing lack of capacity to do so. Also, the scientific authors and editors of the report series have to negotiate the inclusion, or not, of numerous comments on drafts with government delegations.

Hoppe et al. (2013) assert that boundary organisations use “boundary objects” to make up a “symbolic world” for coordinating activities of scientists and policymakers. In this sense, the Emissions Gap reports are boundary objects. The reports are written largely by scientists but are overseen by a Steering Committee consisting mostly of climate policy makers. The executive summaries of the first five Emissions Gap reports were drafted by the UNEP Chief Scientist, revised in accordance with input from participating scientists, and approved by the Steering Committee.

3.5 Dissemination and other factors

Another route of impact of the Emissions Gap reports has been through widespread dissemination of the reports and engagement with users. The reports are released each year at a public/media event a few days before the beginning of the climate Conference of Parties to maximise its take up by COP delegates. In the early years of the report symbolic locations were used for these events (e.g., the Royal Society of the UK). Above we described the wide media coverage and engagement activities associated with the report.

4 Lessons learned

We have argued in this paper that the Emissions Gap reports fill a critical niche in the international climate regime by giving an annual update of the adequacy of cumulative country emission pledges in meeting temperature limits set by the Paris Agreement. This is a key element of the “ambition-raising, stocktaking” policy of the Agreement.

We have provided evidence that the reports are having a direct impact on climate policymaking especially as they are used by the UN Secretary General and many country climate delegates to motivate or justify policies for ramping up emission reduction pledges of countries. We have noted, however, that we have not assessed the possible direct effect of the reports on the size of the gap, although the gap remains wide. The reports are also having an indirect impact, for example in raising awareness about the emissions gap through numerous high-level briefings and extensive media coverage.

To achieve this impact it is our view that the following factors have been particularly important:

- The reports were very timely in that they provided key information at the right time to climate negotiators about the adequacy of country emission reduction pledges.
- The reports helped frame the problem of “ambition-raising and stocktaking.” They distilled the complexity of global temperature limits and emission trends from over a hundred countries into a more understandable narrative about an emissions gap.
- We hypothesize that the design of the reports was an enabling factor. The report series is credible because it provides an impartial synthesis of results from many different scientific groups; it maintains a high level of scientific quality including a depiction of uncertainty of estimates. It presents not only the analysis of a problem (the emissions gap) but also solutions.
- The reports are produced by a major international boundary organisation, UNEP, which provides them with an internationally credible base, as well as making available ongoing funding and support for the report series. The success of the reports is a clear example of the importance of a boundary organisation in bridging the science and policy communities. (An interesting question is whether this role could have been played by an NGO or other type of organisation rather than a UN organisation. Perhaps being a UN organisation was a critical factor since the climate COPs are a UN institution.)

We presume that the success of the report series stems from a combination of the preceding factors. Insight into which factors were more important could be gleaned by surveying climate policymakers that use the reports. This survey could also be used to test out the various assertions made in this paper about the reports’ impact.

The fact that the emissions gap remains wide, despite annual editions of the report, is worrying. Perhaps additional efforts, including a reform of the design of the Emissions Gap report, should be considered.

Summing up, the experience of the Emissions Gap report series provides an important general lesson for the scientific community: It is possible that scientific research, under the right circumstances and with special effort, can fill an important niche in the policy landscape and beneficially inform and influence climate policymaking.

Data availability statement

The original contributions presented in the study are included in the article/[Supplementary material](#), further inquiries can be directed to the corresponding author.

Author contributions

JA: Conceptualization, Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing, Resources. AO: Conceptualization, Data curation, Investigation, Methodology, Resources, Writing – review & editing. NH: Conceptualization, Investigation, Methodology, Resources, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fclim.2025.1534267/full#supplementary-material>

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