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Paris Agreement progress lowers higher-end global warming prospects by about 1°C

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Abstract:

Since the adoption of the 2015 Paris Agreement, countries have put forward emission reduction pledges which altogether would keep global warming below 2°C with greater than 50% probability. Policy implementation lags these pledges but has nevertheless markedly impacted the outlook. Policy implementation and shifts in, for example, technology costs have lowered end-of-century global warming prospects since 2015 by about 1°C, yet still imply exceeding 2°C and 1.5°C of global warming by a large margin.

Main text:

2025 marks a decade since the adoption of the Paris Agreement[1], and 2026 marks a decade since its entry into force. From the onset hailed as a historic step in humanity's response to the threat of climate change, it set out a new architecture for international climate action. A sequence of periods where countries pledge actions, known as Nationally Determined Contributions (NDCs), and global stocktaking exercises in which collective progress towards the goals of the Paris Agreement is assessed, is repeated in five-yearly intervals. Supporting these ratchetting cycles are years in which finance is pledged, and instances where countries are invited to present long-term visions for their economies, known as Long-Term Low Emissions Development Strategies (LT-LEDS).

The ambition of the Paris Agreement is high: to hold global warming well-below 2°C while pursuing efforts to limit it to 1.5°C, ensure commensurate adaptation is achieved and that finance is made available. Pledged NDCs and LT-LEDS submitted since 2015 have jointly lowered projections of how much warming the world would need to cope with over the course of this century, currently centring their estimates below 2°C.[2–5] However, what is pledged is not yet implemented, and scientific assessments have consistently highlighted the existence of an implementation gap between pledges being tabled and policies and measures being implemented.[2,6]

Here, we inventorise and explain the evolution of global warming projections over the past decade that rely not on the pledges and promises, but on more conservative assessments of national policies that are adopted or being implemented. We compile several pieces of information. First, the projected global greenhouse gas (GHG) emissions for the year 2030 and beyond implied by policies as estimated in each year since the adoption of the Paris Agreement in 2015 by two key sources: the Climate Action Tracker (www.climateactiontracker.org), a non-governmental research consortium that tracks international climate policy, and the UNEP Emissions Gap Reports (EGR, www.unep.org/resources/emissions-gap-report), which provide a scientific synthesis of studies available in the literature in any given year under the auspices of the United Nations Environment Programme (UNEP). Second, we also compile the corresponding global warming estimates for the 21st century, as reported annually by these sources.

How emission prospects changed

Near-term GHG emissions projections for the year 2030 based on policies that have been adopted and are being implemented have declined markedly since the 2015 adoption of the Paris Agreement (Fig. 1a). GHG projections for the year 2030 stood at around 20% above 2015 levels during the 2015

to 2018 period (range 16 to 28%, due to a variety of factors[7,8]). However, in the subsequent period they saw a marked decline, reaching their lowest projected levels in the estimates that were carried out in the 2023-2024 period. During this period, current policies were projected to lead to year-2030 emissions that are only about 2-4% above 2015 levels, with uncertainty ranges spanning -6% to +9% indicating that the achievement of a peak in global GHG emissions might have become plausible at that stage. In the last available data year, for estimates made in the year 2025, current policy projections are up across all sources, with particularly Climate Action Tracker indicating year-2030 emissions that are once again 10% higher (range 7-13%) than 2015 levels[9], mainly as a result of climate policy rollbacks in the United States of America (US).

There are several drivers for the general downward trend in current policy projections over the past decade, mainly centring around the progression of policy implementation and changes in the economic outlook. While the coarseness of our data does not allow a fractional attribution to single drivers, examples of new energy and climate policies are those implemented through China's Five-Year Plans, the EU's Fit-for-55 and REPowerEU plans, the US Inflation Reduction Act (and those parts that were not reversed subsequently) and policies in Canada, South Korea, South Africa. The policies are reported to lower current policy estimates since 2015[10–12] and they supported declining technology costs and improved efficiency of renewables, making these technologies increasingly competitive with fossil fuels over the past decade and leading to their rapid expansion.[13] The economic outlook has also changed. In particular, the COVID-19 pandemic, its emissions and energy demand dip[14,15], and associated economic outlook adjustment caused emissions projections from current policies to be lowered from 2020 onwards.

Our analysis also shows temporal lags between the estimates, mainly in the 2018 to 2021 period (Fig. 1a), where the UNEP EGR maintained higher emissions estimates than the Climate Action Tracker, as well as in the estimate for the most recent year. The different nature of the two initiatives explains most of this discrepancy. Climate Action Tracker closely tracks climate policy developments and publishes estimates of their consequences with short delay. Meanwhile, the UNEP EGR is a synthesis report, drawing on estimates from a variety of published sources. The synthesis approach naturally results in a lag between estimates appearing in the public domain, the scientific literature and ultimately in the UNEP EGR synthesis assessment. For example, 2018-2021 was a period of significant climate policy progress and includes the COVID-19 pandemic. COVID-19 impacts on emissions projections of current policies were integrated in the Climate Action Tracker estimates in 2020, while the UNEP EGR integrated them in 2021. The mismatch in the estimated emission rebound in the final year, which is driven by the policy reversal in the US, is due to Climate Action Tracker estimating a

stronger effect that other studies included in the UNEP EGR synthesis. Most recent studies confirm the direction of the estimate by Climate Action Tracker, indicating that current GHG projections under current policy are once again pointing to values well above 2015 levels in 2030.[16,17]

Beyond 2030, projections of implemented policies were initially foreseeing an increase in global GHG emissions until the second half of the century. Recent estimates here show a possible peak before 2030 and then a gradual decline (Fig. 1b).[9,10,13] While historical emissions have increased since 2015, the projections suggest that a lowering of global GHG emissions is now more plausible. What may reinforce that trajectory the post-2030 trajectory is extended using information from long-term scenarios (see below), which inherit assumptions on technology cost, and how these develop, generated several years before the most recent estimates. Observed cost declines for mass-manufactured technologies, like solar photovoltaics, electric cars and batteries, have typically outpaced scenario assumptions.[18,19] On the other hand, renewable energy integration constraints are generally underrepresented, so that the net direction on post-2030 projections remains unresolved.

How global warming prospects changed

The next step considers global warming implications of the current-policy GHG emissions projections. Estimating these consists of two steps: first, GHG emissions are projected over the entire time period for which global warming implications are to be estimates (typically, the end of the 21st century, see Fig. 1**b**) and second, global warming outcomes of these emissions are estimated.

A variety of methods exist to extend nearer-term GHG emissions[5,20] with different initiatives applying their preferred approach, which may have changed over time. For example, UNEP EGR initially compared near-term emissions ranges with corresponding ranges from long-term scenarios to derive implied global warming outcomes.[21] A methodological improvement then allowed to better capture the relationship between near-term 2030 emission levels and resulting global warming from 2016 onward.[22] Finally, from 2021 onwards a further methodological update started using implied carbon prices to project near-term emissions out to 2100, also integrating a more systematic exploration of projection spread across structural model uncertainty and scenario ambiguity.[5] Meanwhile, Climate Action Tracker's method uses the position of near-term emissions relative to an ensemble of emissions from long-term scenarios.[3,23,24] In last emissions-related step, global GHG projections are split up to individual time series of radiatively active species by applying internally consistent species distributions from the literature.[25,26] Finally, global warming is estimated either by comparison to pathways with similar emissions,[21,22] or directly by running probabilistically calibrated simple climate

models,[5,27–31] whose calibrations have been updated over the period considered here as new evidence became available[30].

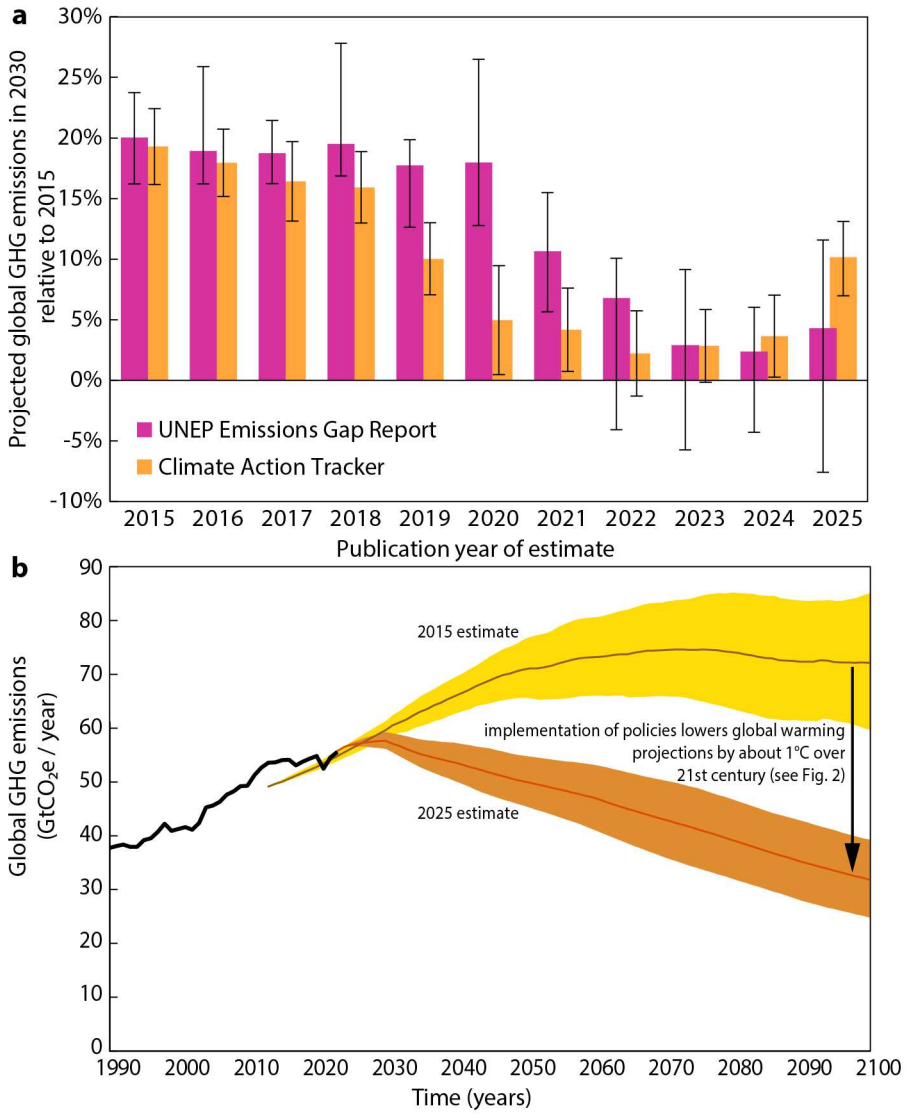


Figure 1 | Evolution of projected greenhouse gas (GHG) emissions under current policy assumptions. ***a****. GHG emission estimates for emissions in the year 2030, grouped by year of publication. Data are shown for the Emissions Gap Reports (pink) and Climate Action Tracker (orange). Whiskers show the minimum-maximum ranges around each respective estimate;* ***b****. Timeseries of the Climate Action Tracker current policy projection estimates published in 2015 and in 2025. The central line is the average across the minimum and maximum estimates. Historical GHG emissions shown in black run from 1990 to 2024 and are from ref.* [32].

Global warming projections from both data sources show a declining trend over time adding up to about 1°C over the past decade but come with differences (Fig. 2). Climate Action Tracker current-policy projections have been produced annually since 2013, with a largely consistent method over time. The result is a gradually declining global warming projection, with the median estimate for global warming by 2100 declining from 3.6°C estimated in 2015 to 2.6°C in their 2025 update. Meanwhile, the UNEP EGR projections show a more scattered picture. Starting out in the pre-Paris reports with a range of 3°C to more than 5°C for the level of global warming that is *likely* (with greater than 66% probability) avoided, this estimate also declined to 2.8°C (66% probability, range 2.2–3.8°C) in the report's 2025 version. The trend has been less smooth because of changes to the assessment method over time (see above). An important distinction between the two sources is also the nature of the ranges that surround the estimates. For the Climate Action Tracker, this represents the uncertainty in how the climate responds to anthropogenic GHG emissions (see Methods). For the UNEP EGR this geophysical response uncertainty is captured providing estimates at different levels of probability. The range surrounding the UNEP EGR estimates reflects uncertainties in how GHG emissions are projected out to 2100.

Note that the UNEP 2025 EGR estimate of global warming declines markedly (Fig. 2) despite 2030 GHG emissions projections slightly increasing (Fig. 1). The main reason for this divergence in trends is that while 2030 current policy emissions projections increased between the 2024 and 2025 version of the report, 2035 emissions declined. The latter are the determining factor for emissions extensions from the 2025 UNEP EGR onward.

Conclusions and outlook

The presented data shows that significant progress has been made since the Paris Agreement was adopted and entered into force in 2015 and 2016, respectively. Most recent global warming projections for current policies indicate about 1°C lower temperatures by 2100 than projections from the year 2015. While this data does not show causality *per se*, the references to the Paris Agreement in national legislation (for example, the 2021 European Climate Law) imply a notable influence. While this exercise provides a picture of progress it also warns against regress. Unilateral decisions, such as the one of the United States of America to withdraw from the Paris Agreement and roll back its domestic climate policies can undo some of the progress. Finally, the progress in lowering projections of global warming under a continuation of current policies should be seen in the context of current levels of global warming. With global warming in 2025 estimated to stand at 1.37°C (1.1–1.7°C, *likely*

range) and increasing at around 0.27°C per decade,[32] it is clear by now that 1.5°C of global warming will be reached over the next decade with important implications for climate risks and the urgent need for an appropriate response.[33]

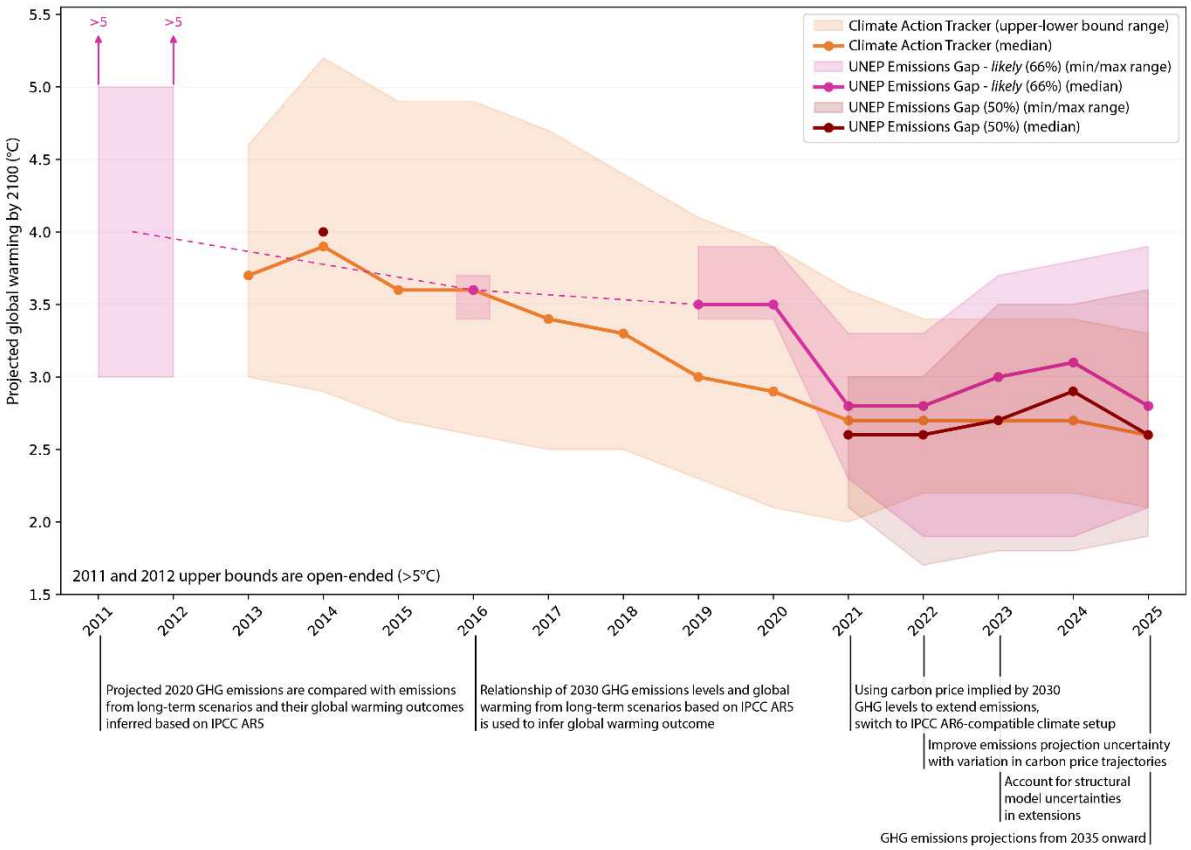


Figure 2 | Evolution of projected global warming by 2100 under current policy assumptions. *Data is shown from the Climate Action Tracker and the annual UNEP Emissions Gap Reports. Climate Action Tracker ranges show the 90th percentile range in global warming projections for their current policy scenario. UNEP Emissions Gap Report ranges show the variation in temperature outcomes at the same percentile of geophysical response uncertainty but for variations in how GHG emissions are projected out to 2100 from their near-term assessed values. Notes at the bottom of the figure clarify methodological changes in the UNEP Emissions Gap Report estimates over time. The dashed line serves as a visual guide to connect related UNEP EGR estimates over years where no data was reported.*

Online methods

We inventorise and compare the annual estimates of 2030 GHG emissions projections and global warming outcomes over the 21st century as reported by the Climate Action Tracker initiative and the UNEP Emissions Gap Reports. Emission data in Figure 1 are expressed relative to 2015 emissions levels as reported by the respective initiatives in their respective annual update reports to ensure easier comparability despite updates to GHG emissions metric values for the Global Warming Potential over 100 years (GWP-100) as reported in the Fourth, Fifth and Sixth Assessment Reports (AR4, AR5 and AR6, respectively) of the Intergovernmental Panel on Climate Change (IPCC).

Compiled global warming projections are for the year 2100 and relative to preindustrial levels approximated by the 1850-1900 period. Global warming projections of Climate Action Tracker are reported for a median value for a single GHG emissions scenario, with an accompanying 90th percentile range representing the uncertainty in the physical climate response to anthropogenic GHG emissions. The UNEP Emissions Gap Reports capture this uncertainty in the climate response by reporting ranges of temperature outcomes at different percentiles of global warming (50th, 66th, 90th). The spread around the central global warming estimate in the UNEP Emissions Gap Reports reflects the potential variation in future GHG emissions over the course of the 21st century when the stringency with which current policies are continued is varied and when different integrated assessment models (IAMs) are emulated to project the corresponding GHG emission implications.

Because compiled estimates span a decade of methodological development, differences between estimates from the range of publication years reflect both changes in projected emissions and changes in assessment methods. The latter include the move to AR6-calibrated emulators, revised aerosol and greenhouse gas forcing parameterisations, updated preindustrial baselines and GWP-100 values, and changes in the scenario ensembles underlying the extension methods. Individual components act in both directions and their net contributions cannot be quantified here. However, the UNEP EGR data compiled for this study shows that methodological changes to capture structural model and parametric uncertainties for GHG emission projections that were implemented across the 2021, 2022, and 2023 editions indicate an upward correction of GHG emissions projections until 2100 for decline 2030 GHG emission levels (Figs. 1 and 2), and previous studies have quantified the shifts due to updated emulator calibrations to be of the order of an 0.1°C increase[34,35].

References

1. UNFCCC. *FCCC/CP/2015/L.9/Rev.1: Adoption of the Paris Agreement*. (UNFCCC, Paris, France, 2015).
2. UNEP. *Emissions Gap Report 2025: Off Target Continued Collective Inaction Puts Global Temperature Goal at Risk*. 76 https://www.unep.org/resources/emissions-gap-report-2025 (2025).
3. Höhne, N. *et al.* Wave of net zero emission targets opens window to meeting the Paris Agreement. *Nat. Clim. Change* **11**, 820–822 (2021).
4. Meinshausen, M. *et al.* Realization of Paris Agreement pledges may limit warming just below 2 °C. *Nature* **604**, 304–309 (2022).
5. Rogelj, J. *et al.* Credibility gap in net-zero climate targets leaves world at high risk. *Science* **380**, 1014–1016 (2023).
6. Fransen, T. *et al.* Taking stock of the implementation gap in climate policy. *Nat. Clim. Change* **13**, 752–755 (2023).
7. UNEP. *The Emissions Gap Report 2015*. http://uneplive.unep.org/theme/index/13#indcs (2015).
8. UNEP. *The Emissions Gap Report 2018*. 112 https://www.unenvironment.org/resources/emissions-gap-report-2018 (2018).
9. Climate Action Tracker. *Warming Projections Global Update - Little Change in Warming Outlook for Four Years; New 2035 Climate Targets Make No Difference*. 34 https://climateactiontracker.org/documents/1417/CAT_2025-11-13_GlobalUpdate_COP30_0Q7kE2L.pdf (2025).
10. Dafnomilis, I. *et al.* The climate policy modelling protocol - Climate policy representation in integrated assessment models. *Energy Strategy Rev.* **67**, 102340 (2026).
11. Nascimento, L., Kuramochi, T. & Höhne, N. The G20 emission projections to 2030 improved since the Paris Agreement, but only slightly. *Mitig. Adapt. Strateg. Glob. Change* **27**, 39 (2022).

12. Kuramochi, T., Den Elzen, M. G. J. & Fransen, T. Chapter 3: Nationally determined contributions and long-term pledges: The global landscape and G20 member progress. in *The UNEP Emissions Gap Report 2023: Broken Record - Temperatures hit new highs, yet world fails to cut emissions (again)* 11–22 (UNEP, Nairobi, Kenya, 2023).
13. Keramidas, Kimon *et al. Global Energy and Climate Outlook 2024: Updating NDCs and Closing the Ambition Gap : Indicators for 1.5°C Alignment*. (Publications Office of the European Union, 2025).
14. Forster, P. M. *et al.* Current and future global climate impacts resulting from COVID-19. *Nat. Clim. Change* 1–7 (2020) doi:10.1038/s41558-020-0883-0.
15. Kikstra, J. S. *et al.* Climate mitigation scenarios with persistent COVID-19-related energy demand changes. *Nat. Energy* **6**, 1114–1123 (2021).
16. King, B. *et al. Taking Stock 2025: US Energy and Emissions Outlook*. https://rhg.com/research/taking-stock-2025/ (2025).
17. Zhao, A. *et al. U.S. Clean Energy Policy Rollbacks. The Economic and Public Health Impacts Across States*. 26 https://cgs.umd.edu/sites/default/files/2025-06/file_CGS_US%20Clean%20Energy%20Policy%20Rollbacks_report.pdf.
18. Creutzig, F. *et al.* The underestimated potential of solar energy to mitigate climate change. *Nat. Energy* **2**, 17140 (2017).
19. Luderer, G. *et al.* Impact of declining renewable energy costs on electrification in low-emission scenarios. *Nat. Energy* **7**, 32–42 (2022).
20. Gütschow, J., Jeffery, M. L., Schaeffer, M. & Hare, B. Extending Near-Term Emissions Scenarios to Assess Warming Implications of Paris Agreement NDCs. *Earths Future* **6**, 1242–1259 (2018).
21. Rogelj, J. *et al.* Emission pathways consistent with a 2°C global temperature limit. *Nat. Clim Change* **1**, 413–418 (2011).

22. Rogelj, J. *et al.* Paris Agreement climate proposals need a boost to keep warming well below 2 °C. *Nature* **534**, 631–639 (2016).
23. Byers, E. *et al.* AR6 Scenarios Database. Zenodo https://doi.org/10.5281/zenodo.5886912 (2022).
24. Climate Action Tracker. Methodology: Global Emissions and Temperatures. (2026).
25. Meinshausen, M. *et al.* Multi-gas emission pathways to meet climate targets. *Clim. Change* **75**, 151–194 (2006).
26. Lamboll, R. D., Nicholls, Z. R. J., Kikstra, J. S., Meinshausen, M. & Rogelj, J. Silicone v1.0.0: an open-source Python package for inferring missing emissions data for climate change research. *Geosci. Model Dev.* **13**, 5259–5275 (2020).
27. Rogelj, J. *et al.* Copenhagen Accord pledges are paltry. *Nature* **464**, 1126–1128 (2010).
28. Meinshausen, M., Wigley, T. M. L. & Raper, S. C. B. Emulating atmosphere-ocean and carbon cycle models with a simpler model, MAGICC6 – Part 2: Applications. *Atmos Chem Phys* **11**, 1457–1471 (2011).
29. Nicholls, Z. *et al.* Cross-Chapter Box 7.1: Physical emulation of Earth System Models for scenario classification and knowledge integration in AR6. in *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* (eds Masson-Delmotte, V. et al.) (Cambridge University Press, 2021).
30. Kikstra, J. S. *et al.* The IPCC Sixth Assessment Report WGIII climate assessment of mitigation pathways: from emissions to global temperatures. *Geosci. Model Dev.* **15**, 9075–9109 (2022).
31. Smith, C. J. *et al.* FAIR v1.3: a simple emissions-based impulse response and carbon cycle model. *Geosci Model Dev* **11**, 2273–2297 (2018).

32. Forster, P. M. *et al.* Indicators of Global Climate Change 2025: annual update of key indicators of the state of the climate system and human influence. *Earth Syst. Sci. Data* **18**, 3889–3933 (2026).

33. Rogelj, J. & Rajamani, L. The pursuit of 1.5°C endures as a legal and ethical imperative in a changing world. *Science* **389**, 238–240 (2025).

34. Kikstra, J. S. *et al.* The IPCC Sixth Assessment Report WGIII climate assessment of mitigation pathways: from emissions to global temperatures. *Geosci. Model Dev.* **15**, 9075–9109 (2022).

35. Nicholls, Z. *et al.* Reduced Complexity Model Intercomparison Project Phase 2: Synthesizing Earth System Knowledge for Probabilistic Climate Projections. *Earths Future* **9**, e2020EF001900 (2021).