Define limits for temperature overshoot targets

Temperature overshoot scenarios that make the 1.5 °C climate target feasible could turn into sources of political flexibility. Climate scientists must provide clear constraints on overshoot magnitude, duration and timing, to ensure accountability.

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To the surprise of many, achieving consensus between industrialized nations, emerging economies and developing countries did not result in weakening the targets for global climate stabilization at the 21st Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC). Instead, in Paris in 2015, the previously envisaged target to keep warming "below 2 °C" was tightened to "well below 2 °C", and supplemented with an aspirational goal of limiting the temperature increase to 1.5 °C.

Here, we argue that, although hailed as an important progressive step, the implementation of this extraordinarily ambitious target could, paradoxically, lead to a weakening of climate policy in the long term. With the focus on a temperature target that is highly unlikely to be met without a temporary period of overshoot[1], the risk is high that temperature targets will no longer be seen as strict upper limits. In the context of real-world United Nations climate policy, such a normalization of the overshoot idea introduces the possibility that political accountability will be lost. We suggest that climate scientists must define clear constraints for temperature overshoot pathways to avoid a 'slippery slope' effect.

Unexpected target

The Paris decision to focus on 1.5 °C as a temperature target caught the climate science community on the wrong foot. Research, including the 2013/2014 Assessment Report from the Intergovernmental Panel on Climate Change (IPCC), had focussed on investigating the hitherto prominent 2 °C target. Neither mitigation pathways towards stricter targets nor impacts that occur between 1.5 °C and 2 °C had been analysed in any depth. Nevertheless, climate scientists knew that aiming for no more than 1.5 °C warming above pre-industrial levels will involve a considerable degree of temperature overshoot[2,3] (Fig. 1); that is, an exceedance of the threshold before bringing global mean temperature back below the intended level (for example, for 50 years by up to 0.3 °C, peaking at 1.8 °C)[4]. But there was — and still is — insufficient knowledge about the geophysical climate responses to such pathways. For example, it is unclear what the overshoot effects would be on issues such as sea-level rise, ice-sheet loss or thawing permafrost, and whether such impacts might be reversible when global mean surface temperature falls below the threshold again[2].

The basic concept of overshoot is, of course, not new. Long before Paris, some emissions scenarios consistent with 2 °C already allowed for deliberate overshoot of atmospheric concentrations of greenhouse gases, with no or only minimal and short exceedance of the ultimate objective before 2100[5]. But, by accepting the UNFCCC's invitation to produce the Special Report on 1.5 °C, the IPCC — and the climate science community — has accepted temperature overshoot scenarios as a new normality. This consequence of the more ambitious target has not reached broad appreciation among the public and policymakers. Specifically, the Paris Agreement does not contain any wording on temporary temperature overshoot, or on its maximum duration or magnitude. Nor does it provide a target time by which warming must be brought back below 1.5 °C, which is a key constraint in terms of achieving accountability.

Implied negative emissions

There are many instances where policymakers take the policy-relevant assumptions agreed upon by the scientific community for granted, but refuse to acknowledge or highlight them politically. The most prominent example is the inclusion of carbon dioxide removal from the atmosphere — also termed 'negative emissions' — in integrated assessment models that allowed for emissions pathways compatible with low stabilization targets. It thus helped policymakers to communicate that reaching 2 °C is still feasible, despite rising emissions.

But the same policymakers refrain from any political commitment[6] to developing and deploying negative emissions technologies at the assumed scale of 670–810 gigatonnes by 2100[7]. The assumptions in current integrated assessment models regarding carbon dioxide removal volumes already constitute a bold bet on the future[8]. Temperature overshoot pathways require aggressive decarbonization to limit the magnitude of temperature rise, as well as massive amounts of net negative emissions to bring temperature down again rapidly after they peak[9] (Fig. 1).

Slippery slope

A deliberate overshoot as part of the temperature targets has the potential to shift their meaning significantly, at least in the realm of climate politics[10]. Because temperature targets have politically been communicated as representing exact (and scientifically defined) thresholds[11], introducing deliberate overshoot carries the risk of change in perception from strict upper limits to mere benchmarks that can be crossed for extended periods of time. Almost inevitably, in the eyes of policymakers and even more so heads of state and government, the basic parameters of overshoot — duration and magnitude — would turn into potential sources of political flexibility. In the discussion of 2 °C pathways, negligible quantities of temperature overshoot were not noted by policymakers or the public, and they certainly did not influence the political debate. In contrast, with a target of 1.5 °C, overshoot would gain a high profile.

Clear definitions for 1.5 °C are lacking among scientists, policymakers and the media, for example regarding baseline pre-industrial temperature or how many years would, on average, need to be above 1.5 °C in order to be considered as exceedance of the threshold[12,13]. Despite — or exactly because of — these inadequacies, the coming decades will see more and more articles and media reports stating that the 1.5 °C line has been crossed already[14]. Public claims that this does not mean that 1.5 °C is lost forever, particularly because the world is working on bringing temperature into decline, will probably help to move the overshoot concept into mainstream thinking.

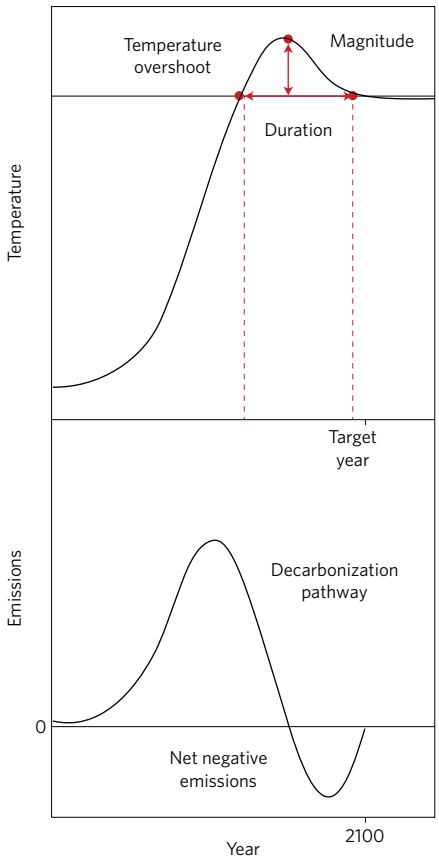

Fig. 1 | Schematic for policy-relevant parameters of temperature overshoot targets. Temperatures will continue to rise for some time after emissions have ceased to rise, and are likely to overshoot a 1.5 °C temperature threshold. Climate scientists should challenge themselves to define firm limits on the duration, magnitude and time limit of such an overshoot, to avoid a 'slippery slope' effect. Figure adapted from ref. [17], Wiley.

Missing accountability

Taking the patterns of real-world climate politics into account[6,10], it is unlikely that in this situation the international community will fight harder to move back below the threshold. It seems that a more likely outcome will be leniency and inconsistencies between talk, decisions and actions within governments. Without clearly defined constraints to overshoot, politicians cannot fail and thus cannot be held accountable for insufficient action. Whatever emissions pathways governments actually follow, they still could state that they are deeply committed to achieve the 1.5 °C target.

When there is no accelerated mitigation beyond the global pathway started with the national pledges made under the Paris Agreement, which brings the world on a track for 3.2 °C by 2100 (with a >66% probability)[7], parties to the UNFCCC would probably be interested to see the relevant timeframe extended beyond 2100 and temperature overshoot also applied to the 2 °C target.

But rather than openly demanding such a lightened mitigation, climate diplomats would probably prefer to motivate scientists to change the relevant assumptions. Such a request could come in the guise of policymakers' standard question under which circumstances it is still possible to achieve the politically agreed climate targets. Subsequently, policymakers tend to cherry-pick from the scientific answers. For example, although the community of integrated assessment modellers is highlighting that meeting the 1.5 °C target means reaching net zero emissions by 2050 at the latest, as well as massive amounts of carbon dioxide removal afterwards, almost every policymaker in favour of 1.5 °C talks only about 'zero emissions by 2050'. The politically uncomfortable necessity of net negative emissions is usually omitted.

To avoid such a scenario, climate scientists need to define constraints for overshoot. Otherwise, climate policymakers, and even more so other branches of governments, could easily miss the urgent need for drastic mitigation, because they are under the impression that even inadequate action will never result in political failure.

Establish standards

Ensuring that mitigation targets — including overshoot pathways — are precise, evaluable and attainable, so that they can fulfill their intended function to regulate action towards goal achievement[15], is a task for all three Working Groups of the IPCC. These issues should be considered in the full Sixth Assessment Report, not just the Special Report on 1.5 °C.

We present five recommendations for the most policy-relevant parameters where standards have to be established and results must be communicated as unambiguously as possible: (1) there should be an agreement to keep the minimum probability level for not crossing a temperature threshold at the well-established 66%, at least in reports targeted at policymakers. Scenarios with lower probabilities and comparably larger carbon budgets — from the >66% dominant in 2 °C scenarios to the >50% still prevalent in 1.5 °C scenarios (or, in IPCC jargon, from 'likely' to 'more likely than not') — seem unjustified, if not misleading; (2) the year 2100 should be retained as a date by which any temperature target has to be met, and hence by which any overshoot must end. If targets agreed upon in 2015 cannot be met by 2100 then it should be called failure; (3) climate scientists should provide clear constraints on magnitude and duration of overshoot, taking into account the geophysical impacts and the specific adaptation requirements of different overshoot profiles; (4) there should be an agreement to exclude any temperature overshoot scenario for 2 °C in future IPCC reports. This would be an easy way to communicate restrictions stemming from the Paris Agreement's intention to strengthen the upper limit to 'well below' 2 °C; (5) and finally, requirements for net negative emissions after reaching the net zero line must be specified, scrutinized for feasibility[8,16] and should become an essential part of any science communication on ambitious mitigation pathways.

These qualifications would strengthen the possibilities to evaluate contributions towards goal achievement politically and help hold governments accountable for insufficient action, even in the case of overshoot targets. Then — and only then — might the Paris Agreement's global climate stabilization targets be able to steer ambitious mitigation action. ❐

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