It's Adaptation all the Way Down

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The debate around "geoengineering" is fraught and complex - and that's easy to tell already by the long discussions people who do research on the topic are ready to have on the term itself. Intergovernmental Panel on Climate Change (IPCC) jargon (to whom we all like falling back to when the need arises) defines geoengineering as "the deliberate modification of Earth's climate". Depending on where you decide the emphasis should be in that phrase you can get yourself to the rhetorical point that everything we do is geoengineering, even driving your car; you know that it emits CO2 and other substances, which you know are bad for the climate, therefore your trip to the grocery store is fundamentally the same as someone dumping mercury in a river (or sulfate in the stratosphere with silly balloons) for profit. Let him who is without sin cast the first stone.

I find it unhelpful to talk about geoengineering without clarifying what the background and motivations are. Global warming driven by an increase in concentrations of long lived greenhouse gasses is a problem, both on its own and as part of the multifaceted challenge of how humans interact and exploit the environment around them (from a Kessler syndrome to nitrogen pollution). These kinds of problems hardly ever cancel each other out, at best don't interact with each other, and at most tend to compound with one another. Their solutions also sometime tend to create new problems (look no further than ozone-depleting substances being replaced with substances with a large global warming potential). Many will argue that such a complex challenge can only be overcome with system-level solutions - overhauling our relationship with the environment, giving up overconsumption (or consumption altogether), rethinking our societal and political structures away from capitalism. Others will argue that our only way out is through - that only technological developement will save us, through a mix of space exploration and expansion, smart resource exploitation and novel technologies.

Likely or unlikely, desirable or not, these discussions are important and yet often miss one fundamental point. Global warming is a real problem now, slowly creeping up and getting worse on us (in a way, too slowly, hence why incentives to reduce emissions are not as strong as they should be) and mainly currently affecting the most vulnerable in the world (both geographically and in terms of economic status) - those who, sadly, have contributed less to the problem in the first place. Reducing emissions as fast as possible is a must to prevent the problem from getting worse. But it is not, in a time frame relevant to humans, a way to restore things to the way they were before. Put it simply: humanity may in the next decades turn around, peak global emissions (they're still growing), bring them to zero at an incredibly fast pace and manage to stay at 2.0ºC above pre-industrial times. That alone will prevent many risks from getting much worse - which is absolutely great, and incredibly crucial - but it won't materially reduce current and short term risks, nor will it protect vulnerable ecosystems and populations at risks from a mix of heatwaves, sea level rise and changes in other extreme events. What else will?

The main answer is, adaptation will reduce many of these risks. Technological transfers and funding programs aimed at reducing inequality and building resilient communities can go a long way towards mitigating suffering[14] and there is no doubt this is what governments should be focus on the most. But adaptation can also go wrong[15] - and the bigger the emergency, the more urgent the need, the higher the risk for the money and the planning to be spent wrongly and result in "maladaptation".

[14] https://www.brookings.edu/blog/the-avenue/2022/07/25/as-extreme-heat-grips-the-globe-access-to-air-conditioning-is-an-urgent-public-health-issue/

[15] https://www.sciencedirect.com/science/article/pii/S2590332220304838

The second answer is, restoring our environment to a previous state by removing greenhouse gasses directly. Many methods have been proposed, from the more benign sounding Afforestation to the more futuristic Direct Air Capture. Each of them is unlikely, alone, to be able to shoulder the unprecedented increase in CO2 concentrations. A synergistic approach that uses them all may potentially help us, over time, making sure we really are a net-zero society, and eventually also reduce concentrations to restore them to previous levels. But, given large uncertainties over both the technological and energy requirements, and the trade-offs in terms of land use necessary, the scalability of these methods up to the point where they could make a difference is not assured - nor is it likely in the first half of this century.

Methods that try to cool the planet by reflecting sunlight away before it reaches the surface (Solar radiation modification, SRM) come in at this point. They do not make sense as a substitute to emission reduction - quite literally, if you keep emitting, warming will continue, and while SRM might "hide" a part of it there are but plenty of robust reasons why it can't hide all of it for ever. The main (but not only) one being, ocean acidification will continue as long as CO2 emissions keep being greater than zero, and SRM does not affect that. Nonetheless, SRM might potentially prevent more warming from happening in a few decades - thereby avoiding some of the risks, while potentially creating some new ones. If the balance of these risks ends up, to the best of our knowledge, leaning towards doing SRM rather than not, doing SRM might end up being the preferable option. While this may sound tautological, it is very much not. If something treats the symptoms without solving the underlying causes, that something might still be worth doing - as long as it doesn't worsen the causes, or as long as it doesn't produce bad outcomes that are worse than the original ones.

This context is often implicit when describing SRM in the context of the 'Napkin diagram', originally described in Long and Shepherd (2014)[16] and then re-adapted numerous times, such as in Fig. 1. Scenarios A and B look identical at the beginning but are fundamentally different as time progresses and, eventually, diverge if SRM is considered as the only way to address warming from CO2. This brings me to my final point, which is: SRM only makes sense if considered through the lenses of *adaptation*, and not through those of mitigation. There is widespread agreement that we can't limitlessly adapt our way out of climate change, as risks can't be assumed to grow at the same steady pace and might eventually overcome our capacity to adapt, especially if considering low-likelihood but high-impact distribution tails. Nonetheless, we need to adapt, and make sure everyone can adapt keeping in mind principles of equity and justice, to reduce suffering. Similarly, we can't limitlessly geoengineer our way out of climate change. Nonetheless, in my view, we will most likely need to do SRM, and make sure we do so in a just way, also to reduce suffering. Adaptation can go wrong - especially if done as an act of last resort, if it ignores the needs of those it's supposed to protect, if badly governed and if its main driver is corporate profit. SRM can go wrong for the same reasons. Just like few would argue against adaptation now (but they have![17]), I expect there is the possibility for a future where protests against SRM will be sparse and it will just be considered "the new normal"[18]. And just in the same way as there are and will be opportunities where short-term thinking and greed have led to bad adaptation outcomes, I expect there is the possibility for a future where SRM might be used as a tool to deepen rather than lessen inequalities.

[16] https://link.springer.com/referenceworkentry/10.1007/978-94-007-5784-4_24

[17] https://www.economist.com/international/2008/09/11/adapt-or-die

[18] On this topic, I suggest the excellent book from Holly Buck "After Geoengineering: Climate Tragedy, Repair, and Restoration" https://www.versobooks.com/products/722-after-geoengineering

The difference between those futures will reside in how "deliberate" we will be with our collective choices, and not with any specific quality of SRM as a tool in itself.

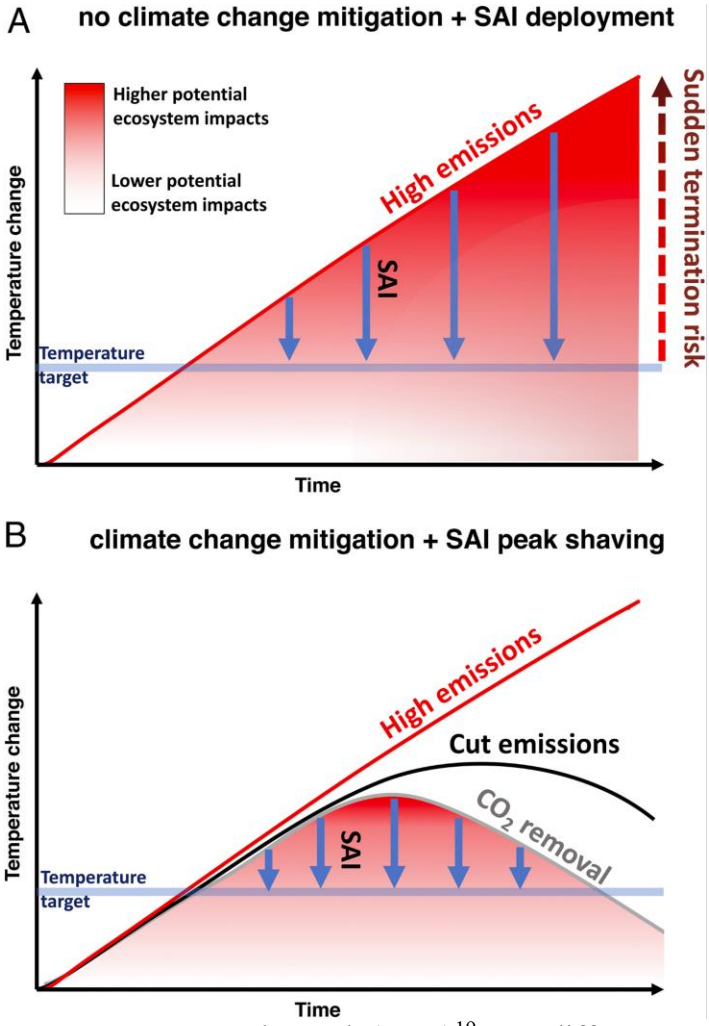

Fig. 1 From Zarnetske et al. (2021)[19], two different ways to consider SRM (here considered as Stratospheric Aerosol Intervention): as a way to completely offset a high emission scenario, with a continuous ramp-up that must go on indefinitely (A), and as a way to complement emission cuts and CDR in order to stay below a temperature target, with a clearer timeframe for wind-down (B). Here temperature change is linked to impacts to ecosystems, but it could be other things (e.g. mortality from heatwaves).

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[19] https://www.pnas.org/doi/10.1073/pnas.1921854118

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