



Climate emergencies do not justify engineering the climate

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Climate emergency – no argument for climate engineering

Jana Sillmann, Timothy M. Lenton, Anders Levermann, Konrad Ott, Mike Hulme, François Benduhn and Joshua B. Horton

Current climate engineering proposals do not come close to addressing the complex and contested nature of conceivable ‘climate emergencies’ resulting from unabated greenhouse gas emissions.

Continuing business-as-usual as regards greenhouse gas emissions will increase the likelihood of ‘dangerous’ climate changes. In response to this risk, Crutzen¹ argued in 2006 that a 5° C warmer world will probably have catastrophic consequences and that the only way out may be to engineer the Earth’s climate by injecting aerosols into the stratosphere. The possibility of a future ‘climate emergency’ has subsequently been used to justify research on climate engineering² – the deliberate modification of the Earth’s climate. Over time, the emergency framing has evolved to become a central argument for why we should consider investigating solar radiation management (SRM) techniques, which reduce the amount of sunlight absorbed at the Earth’s surface. But whether SRM can possibly prevent or counteract a climate emergency raises the more fundamental question of what actually is a climate emergency.

Tipping points

Crossing a tipping point in the Earth system has often been used as an example of a potential climate emergency². Several ‘policy-relevant’ tipping elements have been identified, which could conceivably be tipped by anthropogenic activities this century³. Among these are the Atlantic thermohaline circulation, the West Antarctic ice sheet, the Amazon rainforest, and the West African monsoon⁴. However, whether SRM intervention could actually prevent these elements from tipping, or counteract tipping that was underway, depends on: (1) their predictability, (2) their timescale of tipping, and (3) their reversibility.

A proactive ‘emergency’ response is only conceivable if a tipping point can be convincingly forecast in advance. Whilst early warning signals have been found for some tipping points⁴, the methods do not precisely forecast the time of tipping, and only work if a system is forced slowly relative to the internal timescale of its dynamics⁴⁻⁶. Under relatively rapid climate change, this can prevent ‘slow’ systems such as ice sheets, ocean circulation, or major forest biomes⁷ from giving a reliable early warning signal of approaching tipping. This restricts climate engineering to being a reactive response to tipping that is already underway.

‘Slow’ tipping elements, such as ice sheets^{9,10} or the Amazon rainforest^{7,8} tend to exhibit hysteresis and a high degree of irreversibility. They also tend to lag climate forcing such that by the time tipping is perceived their original state may have long since lost its stability. This means that excessive climate engineering – i.e. over-cooling the planet – is likely to be required to recover their original state (and even then it may not work). The steadily-accumulating consequences of ‘slow tipping’ are also not obvious triggers for a rapid ‘emergency’ response. Notably, evidence suggests that the West Antarctic Ice Sheet has been tipped by oceanic warming during the last 20 years¹¹, yet no climate emergency has been declared thus far. If it were, it is unlikely that SRM would be able to reverse the ice discharge from West Antarctica.

'Fast' tipping elements that could trigger an 'emergency' situation, such as an abrupt shift in a monsoon, are generally related to regional changes in climate. Since SRM, for instance by stratospheric aerosol injection, has much larger scale effects, it is not an obvious response to such a regional emergency and, owing to spatially heterogeneous hydrological responses, may pose more of an additional threat than offer a remedy¹².

Thus, the potential for SRM to respond effectively to tipping point 'emergencies' is very restricted. Even if there was a case where it could be a logical response, there is one final problem: decisions on how much SRM to implement would have to be based on experiments with the same global climate models that had failed to predict the occurrence of a tipping point in the first place. These models would by definition be insufficiently sensitive to climate forcing, and therefore run the risk of recommending an excessive SRM intervention.

Extreme events

Another category of potential climate emergencies are weather and climate extremes¹³, e.g. superstorms, heat waves, droughts or floods. These extreme events may well affect entire regions over the course of years to decades and their impact may spread along economic supply chains around the globe¹⁴. The last decade has seen a series of serious weather extremes¹⁵ and according to the most recent climate change scenarios even more frequent and intense extreme events are likely in the future¹⁶. Yet, it remains unclear whether decreasing the global mean temperature by SRM can reduce the number and intensity of extreme events due to the associated distinct regional pattern in temperature and precipitation changes¹⁷.

Furthermore, the attribution of extreme weather events to specific physical causes is challenging. The question of whether a particular extreme event is caused by human influence or is due to natural variability¹⁸ is central to the public perception of SRM as potential emergency relief. Although there have been advances in detection and attribution of some extreme weather events¹⁹, it will remain difficult to distinguish signal from noise for many types of extreme events (e.g., storms, floods) due to limited observations and insufficient ability of climate models to simulate these events²⁰. Hence, if SRM were to be implemented at some point in time, it would be cost and time intensive, if not impossible, to demonstrate beyond reasonable doubt that SRM prevented, helped, or reduced the occurrence and magnitude of extreme events. Conversely, if a certain high-impact extreme weather event occurred after SRM intervention, it would be difficult to determine whether SRM caused it.

The consequences of any single extreme event, such as Typhoon Haiyan, Hurricane Sandy, or the Russian heat wave of 2010, might be seen as an emergency on its own. But no single event, whether attributed to anthropogenic climate change or not, is a sufficient reason to declare a *global* climate emergency. It is the global interaction of such events with socio-economic and political factors, including elements of power and perception, which might eventually determine their designation as global climate emergencies. In this context of considerable complexity, decisions on the implementation of SRM can only be made within a much broader context than can be diagnosed by natural sciences alone.

Socio-economic emergency

Socio-economic dynamics add a new dimension of complexity to the climate emergency problem. Whilst a purely environmental climate emergency might not even have detectable

socio-economic impacts, an event regarded as a socio-economic climate emergency might be based on very few tangible environmental observations. For example, through complex global supply chains, the effects of extreme local weather events might spread fast¹⁴ and have global impacts on critical socio-economic variables such as food prices, commodity prices, trade flows, migration, etc. A cascade of such damages could lead to a more general socio-economic emergency. Indeed, the perception of a single extreme event as a potential threat for a strategic region might itself lead to considerable political instability.

In this and any sense, an emergency can only be ‘declared’ rather than be ‘discovered’. Whether a given phenomenon is regarded as an emergency is ultimately based on shared societal understandings of what constitutes an emergency and when it is appropriate and legitimate to declare one¹⁹. Emergencies are not just pure facts, but a combination of facts and values, perceptions and interests. This socio-political character of a climate emergency leads ultimately to a number of critical questions²¹ such as: who will be affected?; At what scale?; and, Who is authorized to declare the emergency?”

On top of this complication, a fundamental scientific question remains: Can SRM counteract the climatic root of such a socio-economic emergency? The evidence suggests not, since it is difficult to envision how SRM could be used effectively to address, for instance, interruptions in global supply chains or outbreaks of social unrest. Instead, SRM interventions are likely to result in changes in regional climate patterns²² and these will carry regional to global socio-economic and political implications on their own. Furthermore, early warning signals for such social tipping points are even more difficult to determine²³.

Ethical and political issues

It may not be possible to recognize a climate emergency before it takes the form of a declared socio-economic and political emergency - for which SRM seems obviously ill-suited as a remedy. Since emergencies are combinations of facts and values, they can be ignited by political strategies. They can also, like scandals, be triggered by the mass media or by politicians. The declaration of an emergency situation is ultimately a political act, and thus will inevitably be used for political purposes.

By definition, declaring an emergency invokes a state of exception which carries many inherent risks²⁴: the suspension of normal governance, the use of coercive rhetoric, calls for ‘desperate measures,’ shallow thinking and deliberation, and even militarization. By definition, emergency situations are extraordinary and exceptional. To declare an emergency becomes an act of high moral and political significance, since it replaces the framework of ordinary politics with one of extraordinary politics²⁵. In cases of humanitarian emergencies, for instance, foreign armies might be permitted to operate within a country’s territory. In cases of epidemic diseases, civil liberties might be restricted. If these potential violations of the principles of international law are to be policed, then we need to avoid casual declarations of climate emergencies, even with the best of intentions. Further, if SRM is to be conceived and declared as a pre-emptive strike against putative future emergencies, the analogy to pre-emptive warfare is hard to avoid. The climate emergency narrative as an argument for SRM implementation must therefore be constantly scrutinized, especially when it is claimed to make scientific sense. There are many tragic examples to learn from of where normal politics has been suspended in the name of science and ‘objective evidence’.

No emergency rescue

Solar radiation management may allow for the control of one characteristic of the climate system, for example the global mean temperature. At the same time it can change many other characteristics of the system. Whilst a specific class of extreme climatic events might potentially be reduced under SRM, it remains completely unclear whether SRM increases or decreases other categories of weather extremes, such as those associated with jet stream dynamics or monsoon systems. Currently, our models and techniques are insufficient to predict the tipping of climatic subsystems and these systems are sufficiently complex to prevent human-induced repair after tipping has occurred. Consequently, one can ask whether a climate emergency can ever be prevented by SRM, unless it is declared pre-emptively on the sole basis of unabated greenhouse gas emissions. In this case, an unprecedented amount of risk would have to be taken without knowing which emergencies would actually be avoided or even be provoked.

The danger of declaring a climate emergency is further exacerbated when one considers the political stakes of doing so. Emergencies are by no means simple geophysical occurrences, but rather the outcome of highly complex interactions between the natural environment, political interests and social norms. In the context of considerable scientific uncertainty - and hence the multiple possible interpretations of scientific results and arguments - climate emergencies will be declared on largely political grounds. This interlinking of scientific uncertainty and political opportunism should caution against implementing SRM as a climate emergency measure, a conclusion we reach on the basis of sound scientific arguments, good governance and ethical principles.

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J.S. initiated and structured this commentary, all authors contributed to the content and writing of the Commentary.