Comments on Sillmann et al

I want to add to RobertT's commentary on (Sillmann et al., 2015) and add a couple of comments arising from Robert's.

In brief, Sillman et al is a sloppy piece of work that relies mostly on unsubstantiated conjecture and a miss-framing of geoengineering and a misunderstanding about what constitutes an emergency and responses to it. However, it is an excellent exposition of the muddled thinking against which we have to fight, and as such it would behove us to treat it with some respect and generate coherent and solid responses. RobertT has already made a good start on that. I'll try not to repeat those bits of his analysis with which I concur.

1. Framing

This paper frames geoengineering as 'a response to climate emergency'. But apart from one brief paragraph, the emergencies to which it refers are extreme weather events. They are correct in arguing that AE is not a sensible response to a climate emergency defined as an extreme weather event, whether that has already occurred and the required response is rescue and recovery, or has yet to occur and the required response is to mitigate the expected loss and damage.

Reflecting on this has prompted me to look at the etymology of 'emergency' and its closely associated word 'urgency'. Emergency refers to the state of something emerging, often with harmful impacts and unexpectedly. The key elements here are a) the event is in the process of emerging or has already emerged; b) it has harmful effects; and c) its onset was unexpected. The absence of any one of these three conditions would render the event no longer an emergency. On the other hand, urgency focuses only on the timeliness of action; its origins are rooted in the 'urge', this carries a sense of the drive or compelling force behind an action. Emergency action is almost by definition urgent, but urgent action need not be confined only to emergencies.

> Defining a phenomenon as an emergency implies that it has properties of danger, immediacy, and is to some extent unexpected at least in specific location or timing. (Markusson et al., 2013)

The 'climate emergency' is a reference to a systemic problem, not to a single manifestation of that problem in the form of an extreme weather event or a number of them. Climate change is emerging, it is having harmful effects but its onset is not unexpected. It does not fulfil all three criteria for being an emergency. I believe what those using this expression intend, is to convey a sense of urgency, that climate change is a clear and present danger and we have to react in a timely and sufficient manner to avoid its worst consequences. This notion is perhaps better captured by 'climate crisis'.

AE[1], as Sillmann et al declare, is not an appropriate response to an extreme weather event, what they refer to as 'a given phenomenon'. But they are wrong to then conclude that it is not an appropriate response to climate change. Herein lies the problem, AE is not intended to be an emergency response to climate change because climate change is not, as explained above, an emergency.

[1] Sillmann et al refer only to SAI but imply that their comments apply to SRM/AE generally.

The action required in the face of accelerating climate change is an urgent response that first slows, and then reverses that change. It isn't an emergency because it's not unexpected, even though the precise timing of its effects may be uncertain. However, it is urgent because the onset of cascading irreversible tipping points is becoming dangerously close under a BAU scenario.

Rather than being an emergency response, AE is a prophylactic intervention intended to reduce overall risk to the ecosystem, making it both more robust by lowering the energy imbalance in the climate system that is driving extreme weather events and threatening to trigger cascading climate and social tipping points, and by increasing resilience by reducing stresses on key parts of the ecosystem allowing them more easily to adapt to the changing circumstances.

In brief, we have to stop framing AE as an emergency response to climate change and reframe it as an urgent intervention to limit the loss and damage that would otherwise be caused by climate change.

2. Risk

There is a need to be clear in our language. Risk should be used to refer to the combination of the likelihood of a peril occurring and the loss and damage it might generate if it does occur. Risk is not the probability or the impact but the combination of both. In formal terms, risk is the product of probability and impact (R = P x I). The risks from climate change come as much from low probability high impact events as they do from high probability low impact ones. A very low probability that the global economy will collapse before 2100 amounts to a substantial risk, one that prudence would suggest should be catered for in our policy regime.

A policy regime to cope with uncertain future events must be robust and resilient. As explained in my book (Chris, 2015):

> Robustness here means specifically that:
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> > ... rather than seeking strategies that are optimal for some set of expectations about the long-term future, [policy robustness] seeks near-term strategies [...] that perform reasonably well compared to the alternatives across a wide range of plausible scenarios evaluated using the many value systems held by different parties to the decision. In practice, robust strategies are often adaptive; that is, they evolve over time in response to new information. (Lempert et al., 2003)
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> This extract highlights four conditions for robustness, each of which is necessary but none individually sufficient. Firstly, the many scenarios against which a policy option is assessed need be merely *plausible*, their probability and the credibility of the causal chains that might explain them are of little concern – we know with virtual certainty that highly improbable events will occur, we just have no way of knowing which ones [or precisely when they'll occur]. Secondly, the predicted policy outcomes need to be evaluated 'using the many value systems held by different parties' affected by the decision. This is necessary not only as a matter of political legitimacy but also because it enshrines within the policy process the heterogeneity essential to nourish the emergence of innovations that serve the system as a whole, rather than only addressing the needs of those with a voice.
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> Thirdly, the criterion for acceptability is that the policy need perform only '*reasonably well* compared to the alternatives' and not that it be optimal for any subset of those alternatives. Robust strategies are strategies that are least likely to result in catastrophic failure across

the widest range of plausible futures. Robustness abandons the goal of optimality and promotes survival. It assumes that if we protect against the downside, irrepressible human ingenuity will look after the upside. Moreover, it recognises that beyond our vital needs of food, shelter and security, what constitutes well-being is subject to continuous change making it increasingly challenging for any current generation to know what might be optimal for increasingly distant future generations.

Long-term policy optimality is a mirage. Assuming that the fundamental integrity of a complex adaptive system is not threatened, future members will cope with whatever confronts them and that will constitute their normality. The possibility that their predecessors might have acted differently to create a different and supposedly more desirable future from that which actually unfolds will be confined to the realms of 'if only' conjecturing. They will get on with their lives and like all generations before and after them, make the most of what they inherit and be more or less content with their lot. That the world might have been more or less populous, that people might have been more or less materially prosperous, that technology might have been more or less advanced will count for very little provided that the great majority has food, shelter, security and sufficient human dignity within whatever social structures then prevail. Long-term optimality as a policy objective only makes sense in an unchanging world. That is not the world we have.

Fourthly, robustness implies continuing openness to policy adaptation as conditions change, a concept Walker et al refer to as *dynamic* robustness (Walker et al., 2003). They distinguish it from *static* robustness in which no structural provision is made for the continuing review and revision of the policy. Adaptive policymaking requires a process to be in place *from the outset* to enable the continuous monitoring and reflection on progress that makes the policy adaptation routine rather than occurring sporadically on an *ad hoc* basis.

Another central feature of the robustness approach is that its purpose is to identify near-term strategies that serve long-term objectives. While recognising the intractable uncertainty associated with predicting the distant future, a robustness approach also recognises the need for timely action. It extols the value of embracing that uncertainty 'rather than spending large amounts of time and effort on trying to reduce it, and waiting to take action until the uncertainties have been resolved' (Walker et al., 2013).

Risk is part of the climate change furniture. It's there whatever we do or don't do. The challenge is to minimise it and this is done by making the peril less likely and/or reducing the loss and damage if it happens. The peril is not climate change itself but the loss and damage it causes. If the loss and damage is limited to the occasional extreme weather event such as a flood, drought, wildfire or hurricane, the loss and damage can be mitigated by having well-resourced disaster emergency response services with no need to invest in fixing the climate. But if the frequency and geographic extent of these extreme weather events grows to a point that it overwhelms those services, the loss and damage will be considerable. It's a policy decision as to how much resource to devote to those services and this will depend in large measure on the policymakers' views on the risks from such events (likelihood and impact). The argument for AE is that those risks are now so great that a robust policy regime must include policies that would 'perform reasonably well' in the event that current best efforts to avert a major ecosystem collapse might prove to be insufficient. Crucially, that formulation doesn't work if you wait until the current policy regime has demonstrably failed because then it'll be too late.

This is succinctly encapsulated in Doug Brandt's two aphorisms that I've combined here:

> We must plan for the worst and hope for the best rather than plan for the best, hoping to escape the worst.

In closing this section on risk, a central point that is too often ignored is that the question is not whether AE entails unacceptable risks but whether the risk of a climate change induced catastrophe is now sufficiently great that the fact that it can no longer be mitigated by GHG management, warrants the use of AE by one or more of the many methods of brightening the planet. If that is the case, then the imperative is urgently to undertake the research and development necessary to minimise the risks associated with it.

3. Uncertainty

A major problem with climate change risk is the role of fat tails (Flyvbjerg, n.d.). Determining the probability of catastrophic tipping points is relatively easy, Tim Lenton has done this. What is difficult is to predict their timing. Sillmann et al state:

> 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.(Sillmann et al., 2015)

The logical extension of this argument is that unless our models are sufficiently accurate to predict the future onset of a tipping point and the future unfolding of a climate intervention, no intervention can be justified. The error here is to assume that the only input is from models. Here's a couple more paragraphs from my book that touch on this:

> It is in the nature of surprises that we cannot assess the extent of the structural uncertainty they cause in our models. As Brunner explains, models of complex adaptive systems will always be unreliable because 'the context and rules of interaction of the agents in [such a] system are always open to new experience and insight and the system never reaches equilibrium' (Brunner, 2000)
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> The paradox is that even if more work did result in climate models producing totally accurate predictions, that fact could not be known until it is empirically tested by which time the future will have become the present and the opportunity to influence that present will have been irretrievably lost. It seems that Cassandra's fate is shared by her twenty-first century acolytes [2]. This is not to argue that model predictions have no value, indeed they perform a vital role that in many ways is made more valuable by the wide spread between them so starkly reminding us of the extent of our ignorance. Their importance is in the qualitative rather than quantitative understanding of the interaction between variables.

A critical failure in the Sillmann et al paper is to assume that the only way to resolve uncertainty about AE is to improve climate models. However, since they recognise that that uncertainty is irresoluble, they conclude that there can never be a sound basis for AE. As RobertT points out,

[2] Gifted by Apollo with the power of prophecy Cassandra foretold the fall of Troy, the ruse of the Trojan horse and the death of Agamemnon. However, as a punishment for refusing to become Apollo's consort, he also procured that no one would believe her warnings. Of course, had he not done so and had her warnings been heeded, the prophesies would have been rendered untrue.

uncertainty is resolved by experimentation, by a controlled series of scaled trials in a standard heuristic process. No one has suggested that AE, or any other significant technological innovation would proceed straight from computer model to full scale implementation. This is a Straw Man argument.

Nevertheless, there is a significant operational challenge in designing that heuristic in such a way as to stay within acceptable risk boundaries. This will be highly political and will require extended international collaboration similar to that achieved in the COVID-19 vaccination development. It will be more difficult than COVID-19 because the trials will perforce occur in the open environment and the governance of the research protocols will be far from straightforward.

A particular criticism of Sillmann et al is their ramping up of fears of perverse climatic impacts from AE by reference to a paper that is no more than a call for research, and does not contain any actual evidence to justify their claims (their ref 17).

4. Comments after RobertT

I largely agree with RobertT's comments but he touches on one of my hot buttons – insurance.

I really dislike framing AE through the insurance analogy and regard it is a fundamentally misleading. Insurance is a system of financial compensation for loss and damage. It is a risk pooling system that depends on a peril only afflicting a small proportion of those insured so that the premiums paid by all the insured can cover the insurer's exposure. The insurer can limit his exposure by increasing the policy excess (deductible) and by increasing premiums. He can also reduce the likelihood of the peril arising by requiring the insured to undertake risk prevention measures (burglar alarm, fire safety equipment etc.). Insurance supposes that all loss and damage can be monetised. Insurance is contractual and if those who suffer the loss and damage don't have insurance, they get no protection. Conversely, those paying higher premiums can get greater protection. Insurance is optional in the sense that an individual can choose to carry the risk personally by not taking out insurance.

AE is very different in almost every respect. It is in principle a public good – non-rival (one person's enjoyment does not reduce the amount available for others) and non-excludable (no one can be excluded from enjoying it). In practice, AE might create loss and damage for some but ideally, they would be compensated as best possible by those protected by it. The peril that AE is intended to mitigate afflicts everyone more or less simultaneously and there is limited possibility of risk sharing by those not afflicted. The wealthy are unlikely to be able secure better protection, indeed their greater dependence on system resources and lower capacity of self-reliance in straightened circumstances, may make them even more vulnerable. The benefits from AE are not expressed primarily in financial terms. AE is more about retaining systemic stability than protecting against individual loss and damage.

AE should be framed as necessary to minimise the potential for a systemic phase shift from conservation to collapse[3]. Collapse is an abrupt change. There have been many such abrupt changes throughout human history. We may be on the threshold of the next, but this one is likely to be orders of magnitude more severe than earlier instances because of the size and interconnectedness of the human population and the systems on which it has come to depend.

[3] These are complex adaptive systems theory terms that have specific meanings that are close to their everyday meanings. Complex adaptive systems have a four-phase adaptive cycle – reorganisation, growth, conservation and collapse. Collapse is followed by the next reorganisation and so the cycle goes on.

5. Conclusion

Sillmann et al state:

> if SRM is to be conceived and declared as a pre-emptive strike against putative future emergencies, the analogy to preemptive 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'. (Sillmann et al., 2015)

I agree with this, but this paper mostly does not frame AE as 'a pre-emptive strike against putative future emergencies' but as an emergency response to specific phenomena. They may be right that there are tragic examples arising from the suspension of 'normal politics' but these are valuable learning opportunities not statements of inevitability.

This is a poorly argued paper whose value is in identifying the ground on which we're fighting.

6. References:

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