CLIMATE ENGINEERING

Risks, Challenges, Opportunities?

SPP 1689 WORKSHOP ON 1.5 °C TARGET AND CLIMATE ENGINEERING

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Wrap-up

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Wrap-up of the SPP 1689 Workshop on the 1.5C Target and Climate Engineering, 24–25 November 2016, Kiel

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Preamble: The Workshop has yielded a number of key insights and starting points for the debate about carbon dioxide removal (CDR) and solar radiation management (SRM) research after the Paris Agreement. We here aim to summarise the discussion and the main arguments put forward, noting that this does not present a consensus among the workshop participants, nor is it a position statement. Many issues summarised here were discussed controversely and will evolve as the discussion continues.

Key insights and open issues identified

1.) Carbon budget and 1.5 degree target

There exist virtually no scenario in the scientific literature that reaches the 1.5 degree target without utilizing carbon dioxide removal (CDR), but we cannot yet conclude that 1.5 degrees in 2100 cannot be reached by drastic emission reductions alone. There is uncertainty in the climate response, and the 1.5C carbon budget may or may not be higher than estimated from current models.

Open issues (apart from more general needs to better understand climate sensitivity, carbon cycle feedbacks, the earth system and socio-economic pathways):

- carbon budgets consistent with 1.5C pathways (and within the range of climate response uncertainty)
- reversibility of CO_2 emissions by net negative emissions
- visions for a zero emissions society, including the extent to which residual emissions from freight transport, aviation and shipping, heavy industry and agriculture can be eliminated rather than compensated by CDR.
- the attainable pace of decarbonization to establish such a zero emissions society in a sustainable way, based on aggressive emission reduction strategies for all sectors that tackle high emitters and allow to observe broader sustainable development goals, stay within planetary boundaries and respect human rights
- potential of, and incentives for, carbon capture and storage (CCS) or utilisation (CCU)[1], including monitoring, verification, certification schemes for CO_2 storage
- sustainability constraints on land and ocean use for carbon dioxide removal

2.) Complementarity versus substitution between mitigation and climate engineering

Climate engineering (CE) technologies cannot offer a substitute to deep and aggressive mitigation strategies. If anything, CDR and possibly solar radiation management (SRM) have to be considered as complementary measures. CE is no substitute for mitigation for the following reasons:

[1] CCS captures CO2 from large point sorces such as fossil power plants to store it (usally) in geological formations. CCU considers CO2 not as a pollutant but uses CO2 as a raw material for new products.

a) All CDR technologies can have significant sustainability and social effects (including threats to ecosystems and human rights). They should not be considered without an adequate governance / regulatory framework and proper assessment of their potential socio-economic impacts ensuring that any deployment would indeed follow a sustainable pathway.
b) Current deep mitigation pathways to well below 2C all assume massive mitigation even when taking CDR into account.
c) SRM has a large governance challenge which is unlikely to be addressed effectively if global cooperation on mitigation is not in place. There is the risk that free riding on the mitigation efforts of others is correlated with unilateral SRM deployment.
   Proposing SRM as a long-term fix runs into serious problems of permanence in the presence of an increasing "temperature debt" (= temperatures are kept artificially below their natural levels), implying an increasing risk associated with intermediate abandonment of measures leading to rapid climate change.
   There are also climate change impacts that are not reversed by SRM, such as ocean acidification. And SRM has side effects as well (e.g. on local weather patterns or the ozone layer) which would only become more prevalent if SRM is thought to be applied permanently.
   SRM as a long-term fix (i.e. compensation for positive emissions in the long run) is therefore untenable (and also not compatible with Paris Agreement which calls for emissions neutrality in the 2nd half of the century)

3.) Issues for assessing CDR in the 1.5C debate:

The Paris Agreement considers emission removals by sinks of greenhouse gases without explicitly referring to CDR. Available emission scenarios used, for example, by IPCC, assume CDR (in particular BECCS) to stay within tight 1.5C budget.

Open issues:

- Sustainability profiles of CDR portfolios at different scales relating to permanence (drawing on the concepts of carbon and temperature debt), resource use (energy, water land) and the integrity of oceans, terrestrial biosphere and landscapes and any implications on SDGs.
- Visions of deep decarbonization and of emissions neutral societies to get a better understanding of the possible lower limits on the residual carbon burden (of future emissions that will still occur) and the amount to which CDR would be required to meet the Paris goals. A clear picture about deep mitigation will be an enabling factor for CDR research and deployment, because it informs the strategic needs and uses of CDR.
- Reversibility of temperature response and CO_2 budgets compatible with 1.5C taking into account uncertainty in climate response (there will not be single budget, but a range of budgets within the range of climate response uncertainty).
- What would be the requirements of a (global) governance system that ensures that any CDR deployment would be in line with the 2030 Agenda? How could a global management strategy look like, that is able to adress an array of carbon sinks and CDR technologies?

4.) Issues for debating SRM after Paris:

The legal case for SRM under the UNFCCC and Paris Agreement is less clear than for CDR. Different views exist, including that SRM is not explicitly ruled out given the objective to limit temperature.

Open issues:

- Governance issues: Under what conditions should decentralized interdisciplinary research programs including small field experiments (and in a second step larger field experiments) be allowed to study SRM? Research on processes could help to better assess the possibility and governance of using SRM to respond to „climate emergencies" (higher than expected or tolerable temperatures, e.g. due to climate response uncertainty) or to do peak shaving in overshoot scenarios. This permission should be connected to certain moral conditions. Most importantly, sponsors of these research programs would need to have a strong moral position in supporting rapid mitigation nationally and globally.
- Efficacy of SRM schemes, implications for atmospheric chemistry & ozone, stratospheric heating, hydrological cyle, aerosol and carbon deposition, controllability and governance.

5.) Public discourse

It is key to engage early (i.e. now) in a public discourse on the issue of SRM and CDR in a world which has agreed to collectively limit climate change in the Paris Agreement. This discourse should be informed by science and involve scientists and include stakeholders (such as farmers, indigenous peoples, governments of developing countries…), policymakers and the interested public.

Open issues:

- Investigate and better understand public engagement with deep mitigation, as well as with SRM and CDR, and faciliating factors and barriers for organising a productive discourse about such societally contentious issues.

Wrap-up discussion 1st day (on CDR and 1.5C):

Two questions on CDR and 1.5C:

1) Do we need CDR for 1.5C and how much do we need?
2) How sustainable would it be?

On 1): The difference between the remaining 1.5C carbon budget and lower limit of residual emissions determines the CDR requirement. *Key questions*:

- What is the carbon budget?
- What is the lower limit of residual emissions?
- How reversible is warming when net negative emissions produce a temporary budget overshoot?

The literature on mitigation scenarios tells us that CDR in 1.5C pathways may need to come earlier than in the 2C scenarios (that are emissions neutral by end of 2100), but not necessarily at higher levels (in GtCO2/yr) by the end of the century. How fast it needs to be deployed and what level it would need to reach by 2100 depends on (i) how fast we can mitigate emissions and (ii) to what extent we can establish a fossil fuel free and emissions neutral economy without CDR in the long term.

1.5C scenario comparisons suggest a lower limit of residual fossil fuel emissions of ca. 1000 GtCO2 for 2011-2100 (current emissions: ~36 GtCO2/yr) and calls for massive mitigation.

Key questions:

- Can we go below this massive mitigation by accelerating the transition even further and deploying new technologies to eliminate decarbonization bottlenecks in heavy industry, freight transport, shipping, aviation, agriculture?
- How can we target climate policies to specifically address high emitters and protect the poor?

Lock-in processes have to be looked at carefully (e.g. replacing coal by gas, co-firing of coal power plants) may look good in the short term, but may lock society into fossil fuels for decades).

According to industry, large-scale CCS could be done within a few years (e.g. operational Quest project in Alberta). Need close interaction with local population. There is a need for transitional funding measures/support until a carbon pricing mechanism is in place to make CCS commercially viable. Public subsidies and the use of CCS for enhanced oil recovery can be contentious issues.

How relevant is the moral hazard argument[2] that CDR in the future puts off structural changes and needed mitigation in the near term? It may have been overstated because many 2C scenarios (and 1.5C ones even more so) already use massive mitigation and large scale CDR given the tight remaining budget.

[2] The term moral hazard comes from the insurance context where it describes an increase in risky behaviour once insurance cover is provided. In the context of CE, the moral hazard argument claims that deployment or even research of CE technologies might lead to a reduction in mitigation activities.

On 2): Sustainability criteria include:

a) Permanence: CDR options differ hugely here. Storing carbon in the biosphere builds up a carbon pool that might be vulnerable (e.g. too future warming) and with lower permance than, e.g. CCS in geological reservoirs (might be called carbon debt - liability?)
b) Resource use – Water, Land, Energy
c) Biosphere / ocean / landscape integrity: Responds strongly to CDR scale. The more deployed, the more difficult it is to preserve integrity
d) Interaction with the United Nations Sustainable Development Goals (SDGs), in particular access to food & energy, also health, justice and well-being, protection of ecosystems and biodiversity.

Statements from the discussion:

(1) We need to use CDR as little as possible, i.e. mitigate as much as possible to limit sustainability effects. If needed, use limited CDR strategically to meet negative emissions needs. Portfolios of CDR options that are individually used only to a very limited degree may help to limit sustainability effects. In any case, deployment of CDR technologies like mitigation technologies should not undermine planetary boundaries or human rights.
(2) Need more serious dialogues among policymakers, stakeholdes and scientists. Need discussion how CDR can be considered for Nationally Determined Contributions and Nationally Appropriate Mitigation Action in developing countries. Need to involve political and social scientists and practitioners early on.

Wrap-up discussion 2nd day (SRM and 1.5C and public discourse about CE):

Two questions on SRM and 1.5C:

1) Can SRM be an option to reach 1.5C? Can it be a Plan B if 1.5C is getting out of reach?
2) Do we need research on SRM?

On 1): Sulphur-based SRM may have limited potential, alternative materials may be more promising. Potential risks and impacts for people and ecosystems are largely unknown and can in the end not be known without field experiments that would constitute deployment.

Given large uncertainties in the magnitude of future warming, SRM could be thought of as possible emergency switch. Paris agreement put up temperature targets, not emission limits, and thus is more open to SRM than is the United Nations Framework Convention on Climate Change (UNFCCC). SRM is neither a mitigation nor an adaptation option, but also no prohibition by Paris agreement. Different interpretations of the precautionary principle. Fragmentation of international law.

Free driving (= unilateral SRM deployment) and free riding (= withdrawing from mitigation action while relying on the action of others) are correlated. Strong committment to mitigation must be in place before governance issues surrounding SRM can be resolved. Governance of SRM is the biggest challenge. Also deep questions of democracy involved: who can take a decision on whose behalf?

On 2): Freedom of research should allow for some research under given national and international legal frameworks. Some side effects (ozone loss) depend on complicated aerosol-particle interactions. Not fully understood. Lab experiments needed, but some researchers call for controlled field experiments (lab experiments not enough, nature surprises us). Small-scale field experiments may possibly test some aspects of the respone of the climate system, but testing the full reaction would not be possible without larger field experiments that essentially equal deployment.

Sponsors of research programs on SRM need to have a strong moral position in supporting rapid and deep mitigation nationally and globally.

Need research on governance elements for SRM (and CDR). Governance elements include transparency and information flow, development of standards and norms, assessment of socio-economic impacts and ethical and moral concerns, procedural mechanisms already for field experiments.

Further points in final discussion (including CDR and SRM):

- What is the link between early CDR deployment and a (significant) carbon price in many regions? Would CCS / CDR licensing requirement on fossil fuel extraction make a difference? How could winners compensate losers?
- Some CDR options might be discounted already for pure natural science reasons (low efficacy as e.g. for Ocean Iron Fertilization, side effects as for large-scale afforestation or permanence risks).
- Need to take climate uncertainty into account. Budget approach glosses over it. Can do a sensitivity analysis on budgets, but some feedbacks are ignored such that carbon stored in the biosphere is more at risk under such uncertainty (it might oxidize quicker in a warmer world).
- Focus should be on measures that can bend the emissions curve in the next few years.

- Discussion about focus on near-term no regret options vs problem of lock-in and path dependency. Harvesting only the low hanging fruits will not be enough. Aggressive (radical) mitigation strategies for all sectors of the economy need to target high emitters in every society. Governments need to be prepared to deploy policies that deal with these trade-offs between different parts of their societies.
- CDR options can only make a temporary contribution, need to keep focus on target of zero emissions society without relying on CDR.
- Distributional implications of CDR are important

Examples of stakeholder views:

(Views listed present individual views.)

Concerns about the debate:

- Key concers around CDR / SRM are not only technical ones but also political / societal ones. But "societal concerns" is an euphemism for potential serious impact on human rights (e.g. human right to food, to healthy environment or use and distribution of resources or value conflicts). Human rights are an important element of the Preamble of the Paris Agreement.
- People attending this conference are a very small fraction of a very specialised community and collectively ill-equipped to assess and judge the concerns of important stakeholders (or rather: rights holders) such as farmers in the Global South and indigenous peoples. Those stakeholders are not informed about what is being considered in laboratories and policy circles.
- While there is not much of a dedicated governance regime in place for geoengineering (apart from the CBD moratorium, or the London Convention for ocean iron fertilization), the shaping of the political debate itself is part of the governance: who is part of this? Who has a say? What is not discussed and remains unheard and unthinkable? Creating a global governance system must go hand in hand with bringing up a public discourse around climate engineering.
- Stakeholder views cannot and should not be viewed as an afterthtought or a tick-off box for this crucial topic.
- Many other pathway options (other than climate engineering) are easily dismissed as they seem to be unthinkable because they question the economic and political power of high emitters, economic assumptions or consumption patterns. We are clearly failing to come up with the right answers and need to reconsider which type of knowledge and expertise is needed to address this global crisis.
- Doing research on climate engineering might be confused with an endorsement of climate engineering. There is a high responsibility of researchers when communicating.
- It is alarming that the UNFCCC and Paris Agreement seem to be the central reference for legal assessments of geoengineering at the international level. Others (CBD, London Convention) also should be taken into account. Soft-law is a very important part of international policy, and should be taken seriously.
- When discussing CDR, a broad systemic view is needed. E.g. some future scenarios for a low emission energy system rely on "renewable methane", which would also require CO_2 from the atmosphere.

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