Executive Summary of the EuTRACE Report

Potsdam, June 2015

The European Transdisciplinary Assessment of Climate Engineering (EuTRACE)

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Background and General Considerations

There is a broad scientific consensus that humans are changing the composition of the atmosphere and that this, in turn, is modifying the climate and other global systems. The likely harmful impacts on societies and ecosystems, along with possibilities for mitigation and adaptation, have been documented in the assessment reports of the Intergovernmental Panel on Climate Change (IPCC).

In this context, various researchers, policy makers, and other stakeholders have also begun to consider "climate engineering" (also known as "geoengineering" or "climate intervention") as a further response to climate change. Most climate engineering techniques can be grouped into two broad categories:

- "greenhouse gas removal": proposals for reducing the rate of global warming by removing large amounts of CO_2 or other greenhouse gases from the atmosphere and sequestering them over long periods;

- "albedo modification": proposals for cooling the Earth's surface by increasing the amount of solar radiation that is reflected back to space ("albedo" is the fraction of incoming light reflected away from a surface).

The EuTRACE assessment report provides an overview of a broad range of techniques that have been proposed for climate engineering. Research on climate engineering has thus far been limited, mostly based on climate models and small-scale field trials. To illustrate the range of complex environmental and societal issues that climate engineering raises, the EuTRACE assessment focuses on three example techniques: bio-energy with carbon capture and storage (BECCS), ocean iron fertilisation (OIF), and stratospheric aerosol injection (SAI).

In general, it is not yet clear whether it would be possible to develop and scale up any proposed climate engineering technique to the extent that it could be implemented to significantly reduce climate change. Furthermore, it is unclear whether the costs and impacts on societies and the environment associated with individual techniques would be considered acceptable in exchange for a reduction of global warming and its impacts, and how such acceptability or unacceptability could be established democratically.

Against this background, a broad and robust understanding of the topic of climate engineering would be valuable, were national and international policies, regulation, and governance to be developed. This could be supported by coordinated, interdisciplinary research combined with stakeholder dialogue, taking into account a range of issues, including the potential opportunities, the scientific and technical challenges, and the societal context within which wide-ranging concerns are being raised in discussions about climate engineering.

Opportunities and Scientific and Technical Challenges

Greenhouse gas removal techniques could possibly be used someday to significantly reduce the amount of anthropogenic CO_2 and other greenhouse gases in the atmosphere. This could present an important long-term opportunity to limit or partly reverse climate change, given that anthropogenic CO_2, once emitted, remains within the climate system for more than a hundred years on average. However, such techniques face numerous scientific and technical challenges, including:

- determining whether the techniques could be scaled up from current prototypes, and what the costs of this might be;

- determining the constraints imposed by various technique-dependent factors, such as available biomass;

- developing the very large-scale infrastructures and energy inputs, along with the accompanying financial and legal structures, that most of the proposed techniques would require; based on existing knowledge and experience, this could take many decades before it could have a significant impact on global CO_2 concentrations.

For albedo modification, initial model simulations have shown that several proposed techniques could potentially be used to cool the climate significantly and rapidly (within a year or less, and possibly at relatively low operational costs). This would be the only known method that could potentially be implemented to reduce the near-term impacts of unmitigated global warming. However, in addition to the societal concerns outlined in the next section, it is unclear whether any of the proposed albedo modification techniques would ever be technically feasible. There are numerous scientific and technical challenges that would first need to be addressed to determine this, including:

- very large and costly infrastructures that land-based techniques would require;

- delivery mechanisms for techniques based on injection of aerosol particles into the atmosphere, including delivery vessels (e.g., high-flying aircraft or tethered balloons) and associated nozzle technologies;

- a much deeper understanding of the underlying physical processes, such as the microphysics of particles and clouds, as well as how modification of these would affect the climate on a global and regional basis.

A further challenge that generally applies to both greenhouse gas removal and albedo modification is that their application could result in numerous technique-specific harmful impacts on ecosystems and the environment, many of which are presently uncertain or unknown.

Societal Context

The development and implementation of any of these proposed climate engineering techniques would occur within a complex societal context where numerous concerns arise, including:

- public awareness and perception;

- the "moral hazard" argument (the concern that research on climate engineering would discourage the overall efforts to reduce or avoid emissions of greenhouse gases);

- the sense of environmental responsibility in the Anthropocene;

- possible effects of various climate engineering techniques on human security, conflict risks, and societal stability;

- expected economic impacts;

- justice considerations, including the distribution of benefits and costs, procedural justice for democratic decision making, and compensation for harms imposed on some regions by measures that benefit others.

It can be expected that these concerns, as well as the scientific and technical challenges discussed above, would take considerable time to resolve, if this is at all possible. Thus, it appears imprudent to expect either greenhouse gas removal or albedo modification to play a significant role in climate policy developments in the next decade, or even within the next several decades, although it is possible that one or more of the climate engineering techniques that are currently being discussed will become an option for climate policy in the latter half of this century.

Development of Policies, Regulation, and Governance

Developing effective regulation and governance for the range of proposed climate engineering techniques would require researchers, policy makers, and other stakeholders to work together to address the uncertainties and risks involved. At present, no existing international treaty body is in a position to broadly regulate greenhouse gas removal, albedo modification, or climate engineering in its entirety. The development of such a dedicated, overarching treaty (or treaties) for this purpose would presently be a prohibitively large undertaking, if at all realisable.

Thus far, two treaty bodies, the London Convention/London Protocol (LC/LP) and the Convention on Biological Diversity (CBD), have taken up discussions and passed the first resolutions and decisions on climate engineering. Furthermore, it has often been suggested that the United Nations Framework Convention on Climate Change (UNFCCC) could contribute to regulating various individual techniques or aspects of climate engineering.

In light of this, one option that the EU could follow if it were to decide to try to promote a more coordinated approach to the regulation of climate engineering would be to bring together the LC/LP, CBD, and UNFCCC at the operational level. This could be done, for example, through parallel action, common assessment frameworks, and Memoranda of Understanding. A further option for EU member states (which are all parties to both the UNFCCC and the CBD) could be to pursue an agreement on a common position on various techniques or general aspects of climate engineering. In particular, such an agreement could be made consistent with the high degree of importance that EU primary law places on environmental protection.

For the more general development of climate engineering governance (in addition to formal regulation), the EuTRACE assessment highlights five overarching principles for guiding the academic research community and policy makers:

- minimisation of harm;
- the precautionary principle;
- the principle of transparency;
- the principle of international cooperation;
- research as a public good.

Based on these principles, the EuTRACE assessment proposes several strategies that could broadly be applied across all climate engineering approaches in support of developing effective governance:

- early public engagement, including targeted public communication platforms;
- independent assessment;
- operationalising transparency through adoption of research disclosure mechanisms;
- coordinating international legal efforts through activities like those discussed above, e.g., common assessment frameworks, as well as through development and joint adoption of a code of conduct for research;
- applying frameworks of responsible innovation and anticipatory governance to natural sciences and engineering research.

Should the EU decide to develop clear and explicit policies for research on climate engineering, or its potential future deployment, then a conscientious application of the principles and strategies discussed in the EuTRACE assessment may help ensure coherence and consistency with the basic principles upon which broader European research and environmental policy are built.

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