

# **Governing Climate Engineering – A Transdisciplinary Summer School**

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Between the 12<sup>th</sup> and the 16<sup>th</sup> of July, more than forty international students and twenty professors from a wide range of disciplines including Human Geography, Philosophy, Political Economy, Political Science, Psychology, Law, Environmental and Climate Physics, as well as Economics met in Heidelberg at a week long summer school to discuss the issue of Climate Engineering (CE). Speakers included pundits from various fields, including international governance expert Catherine Redgwell, environmental physicist David Keith, atmospheric chemist Thomas Peter, environmental economist Timo Goeschl, and meteorologists Philip Rasch and Alan Robock, as well as the man credited with enlivening the CE debate with his seminal essay on the topic; Paul Crutzen.

The aim of the event, which was jointly organised by the University of Heidelberg (Germany), the University of Calgary (Canada), Carnegie Mellon University (USA) the Max Planck Institute for Comparative Public Law and International Law, was to encourage the open exchange of ideas and expertise during a series of lectures, workshops and discussion groups. A mixture of single and multidiscipline workshops and discussion groups ensured that both intra- and interdisciplinary dialogue was possible, while the varied symposium formats promoted diverse learning effects.

This report will focus on interdisciplinary exchange, with the aim of showing not only how this kind of exchange occurred, but also indentifying controversial points which arose, presenting the argumentative methods employed by participants regarding the risks and benefits of CE, as well as providing a catalogue of questions which remained unanswered at the conclusion of the summer school.

## **Interdisciplinary exchange**

During the Summer School, interdisciplinary exchange centred on the exchange of information regarding the assumptions made by experts from different fields and the perspectives which emerge from the acceptance these assumptions. It became clear that

this process of understanding the varied perspectives of multiple disciplines is essential to identifying common research questions and frameworks which allow informed discussion.

Because many different disciplines engaged in the 2010 CE summer school, different approaches to ensuring successful interdisciplinary communication were integrated into lectures and workshops. In general, questions and information exchange opened disciplines to other fields and allowed participants to consider concepts that had not been implemented by their specific discipline before. There was consensus that interdisciplinary work is essential for CE to allow informed decisions that include all those involved in the field of CE methods. During the course of the summer school, several concrete examples emerged of the way interdisciplinary cooperation can be beneficial.

From a natural science perspective the impacts of CE are investigated by means of climate system modeling as presented by lecturers such as David Keith and Thomas Peter during the summer school. Uncertainty about the impacts can be included in those models. In turn, economists utilize these findings in their models to provide policy-makers with further information about the consequences of their decisions with respect to CE.

In addition to this, political sciences and legal studies not only consider impacts on the climate but also impacts on humans and governmental structures or institutions. In the discussions, summer school participants also emphasized that - apart from the climatic system - water supply, agriculture, food supply, human perception and ultimately national security would also be affected by CE. Therefore, there was a consensus among participants that a combination of natural sciences and social sciences is essential to finding the optimal way to model CE consequences and understand the risks for ecosystems, economies, and individuals.

Apart from risk and uncertainty, the costs of CE approaches were a theme during the summer school meetings. Every discipline has its distinct definition of costs. On the one hand, costs might only be calculated in direct, monetary units. Hard data can be collected for the purpose of calculating these direct cost measurements and decisions about affordability are explicit. Nevertheless, disciplines agree that other types of costs must be included in the CE debate. Social sciences use indirect costs that affect society as a whole, but they also address fields that implicate costs for ecosystems and individuals. It became clear during the

summer school that although indirect costs cannot be measured easily, different disciplines can support each other to model a more accurate image of CE consequences and their costs. Therefore, the need for scientists to combine different cost types in joint models to develop a realistic image of the world was emphasized by participants from all disciplines.

### **Controversial points**

Despite the fact that the interdisciplinary exchange was largely successful during the event, there were some points which gave rise to misunderstandings. Most of these arose from the fact that all disciplines use different terms and definitions regarding CE, and it became clear that it is important for disciplines to understand the language and assumptions accepted within different fields. Some examples which demonstrate potential interdisciplinary differences of opinion are divergent perspectives regarding effectiveness, risks, impacts, and costs of CE methods. From a natural science standpoint, for instance, some CE methods are relatively easy to develop. On the other hand, social scientists argue that impacts on ecosystems and humans are sometimes neglected in natural scientists' cost and impact calculations.

In addition, it became apparent that the disciplines have distinct opinions on who engages in CE activities and to whom consequences occur. Whereas participants from the fields of political science and human geography focused on individuals and governments, economists expanded the scope of those affected. Legal studies experts emphasized the relevance of institutions whereas natural scientists excluded humans from their observations of the climate in order to investigate consequences for climatic systems under CE. Furthermore, compensation and liability are affected by the different definition of actors to be included in the models.

Another controversial point raised regards the funding of CE research and the interaction of scientists with the political sphere. On the one hand, participants voiced the opinion that including governments and their institutions is important for research and the success of developed methods, but on the other hand, there was anxiety that science could become "politicized".

An additional issue that gave rise to discussion is the timing for including different disciplines in CE research. Natural scientists develop their instruments and methods independently and tend to include social scientists and policy-makers at a later stage of the process. Those from humanities regarded it as vital that they assume a more active role from the beginning of the research process

The summer school included participants of different nationalities from all five continents. Nevertheless, some participants argued that discussions were rather from a “northern”, “developed countries” perspective. It became clear that it is crucial to include not only different disciplines in subsequent projects, but also to understand the interests from a “southern”, “developing countries” perspective to make informed decisions on CE.

These and other controversial issues provided material for lively debate, which was assisted by a variety of argumentative methods, some of which will be detailed in the following section.

### **Argumentative methods**

During the course of the week, the relaxed atmosphere encouraged open discussion which allowed various perspectives regarding the feasibility, viability and ethical responsibility of conducting research into CE to come to light. These perspectives can be roughly classified into four categories, namely opinions regarding technical viability, economic feasibility, political and legal issues as well as moral or ethical considerations.

The debate surrounding the technical viability of various CE technologies was mainly led by the Environmental Physicists and focused largely on the technical merits of the so-called Solar Radiation Management (SRM) methods currently being investigated as part of the CE field. An example of one of these methods is the reproduction of the effect of a large volcanic eruption by means of introducing aerosols into the Earth’s stratosphere. These aerosols would then reflect more solar radiation and thereby cool the Earth’s atmosphere. The main technical argument used in support of investigating this method is the fact that the analyses of volcanic eruptions of the past provide information as to how such an injection of particles into the stratosphere works. This argument was supported by some at the summer school who referred to the fact that the technology needed to implement such an injection

of particles is thought to be relatively simple and is currently available. These points in favour of the method were, however, mirrored by several reservations.

Those who voiced technical scepticism regarding aerosol injection as a means of SRM suggested that current models are not able to incorporate all factors needed to adequately predict the way the injected particles behave in the stratosphere. Although data exists based on the way particles released by volcanoes react, questions were raised regarding to what extent such data can be applied to calculate the behaviour of injected particles. Additionally, the point was made that climate modelling is currently unable to comprehensively calculate the effects such a method would have on global climate systems. On the other hand, questions were raised as to whether experiments could be performed to test the feasibility of SRM measures. Some held the opinion that it would be impossible to test such methods without actually implementing them on a scale large enough to have a climatic impact.

Economic pundits were likewise divided on the costs and benefits of different methods of CE. Despite the fact that some early calculations presented showed aerosol injection to be one of the most cost-effective means of SRM, it became apparent during the course of the summer school that a much wider economic perspective was needed. Such a perspective, according to opinions voiced, needs to encompass not only direct costs associated with the implementation of this method and others, but must also include the risk of climate impacts and uncertainty through exogenous variables.

The discussion surrounding the political and legal aspects of CE centred on the issue of the difficulties surrounding the permission and regulation of trans-boundary research and implementation. Differences of opinion became apparent regarding the level and type of regulation needed, and regarding what type of entity should be responsible for this. While some participants expressed the opinion that new legislation and international treaties are needed, perhaps even in connection with the establishment of an independent international governing body, others were of the opinion that existing national and international legislation can be altered to encompass regulation of CE research and implementation. The latter argument in favour of altering existing legislation was based on the idea that CE can be best handled if it is addressed as a general environmental issue, while those who advocated the former argument considered CE to be a 'special case' which required the establishment

of specific legislation and regulations. This viewpoint was supported by the argument that CE presents a unique situation due to high levels of risk associated with its potential trans-boundary and trans-generational effects.

The liveliest discussions held during the week focused on the ethical and moral implications of researching and eventually implementing CE methods. Some argued that researching CE methods was irresponsible, as it could lead to the development of technology and knowledge which could then be potentially harmful for the global environment and humanity. Others countered by emphasising that continued research is absolutely necessary to be able to make an informed choice on the matter. Even several participants who openly voiced their scepticism towards CE spoke out in favour of continued research on the topic. They based their conviction on the argument that comprehensive knowledge of the possible risks and benefits of CE methods is imperative to be able to make informed decisions about its implementation in the future. They supported this stance by expressing the opinion that the 'slippery slope' argument advocated by those against research on CE does not take into consideration the role of institutions in preventing complete research and development autonomy.

In addition to this, it was maintained by some that continued research into CE measures could lull societies and governments into the belief that emissions mitigation is no longer essential, as CE will provide the 'quick fix' needed to prevent dramatic climate change associated with anthropogenic global warming. However, proponents of continued research repeatedly accentuated that research into CE should go hand in hand with sustained mitigation efforts. The calls for the continuation of research into CE were also supported by the argument that independent calculations predict a temperature increase within the next century even if CO<sub>2</sub> emissions were reduced to zero today, meaning CE measures may become indispensable to prevent the effects on mankind and the environment associated with such warming.

### **Open questions**

Despite the fact that the extensive discussions allowed many questions be resolved, they also lead to new questions being raised, not all of which were able to be answered satisfactorily during the five days of the summer school. These open questions can also be

roughly classified into four categories, namely technical, economic, political and legal, as well as moral and ethical questions.

Technical questions which were raised during the course of the summer school mostly focused on the feasibility of the aforementioned aerosol injection method of SRM. These included queries regarding the possible side-effects of stratospheric warming, for example on the formation of clouds in the troposphere, or to what extent the injection of sulphur particles would negatively affect the ozone layer. Multiple questions were raised regarding the effects SRM would have on the global climate, with models suggesting considerable, but as yet unverified, effects on rainfall patterns. One very relevant question raised was how long this means of SRM would have to be continued without risking serious climate change upon cessation. In connection with this issue, the question was posed as to what would happen if SRM were implemented, but had to be suddenly interrupted, for example in the case of the collapse of international cooperation or war. Would this lead to rapid warming and serious side-effects?

Economic questions mainly revolved around the issue of moral hazard and to what extent the source of funding would affect the risk taking behaviour of those involved in CE research and development. The question of patenting was also raised, leading to the question as to whether CE methods should be allowed to be patented or not. The patenting of a certain method could lead to vested commercial interest in its implementation. On the other hand, patenting would allow the regulation of its use.

Political and legal questions raised were many and varied, ranging from possible forms of regulation, over the role of societal participation in decisions regarding research on and eventual implementation of CE measures to questions regarding the likelihood of CE becoming a security issue.

Regarding regulation, the specific questions which remain to be answered include whether it makes more sense to modify existing international treaties or to create new ones which deal explicitly with CE. Issues related to this question are with how such regulations should be enforced, and how soon governance structures need to be put in place. Question which sparked particularly animated discussion concerned whether governance structures need to

cover lab research as well as field experiments, as well as who will be liable for possible negative side effects of CE methods.

The issue of societal participation in decisions regarding CE measures gave rise to several questions worth mentioning, including how a decision regarding whether to implement a global CE measure should be made and who should be involved in such a decision. In connection to this, questions regarding to what extent public participation is desirable and/or practical was raised and how scientists can communicate effectively with the public regarding CE.

Questions pertaining to the potential of CE to become a security issue include the question of how likely it is that one state could 'go it alone', as well as queries as to what incentives are there for states to cooperate on this issue. This led to the question of if and how it will be possible to prevent conflict between those who are seen to benefit from CE and those who are seen to suffer from (perceived) negative side-effects.

Moral and ethical questions regarding CE research and implementation spanned all disciplines taking part in the summer school. Some of the most frequently asked questions pertained to the role of scientists of all disciplines in the development of such measures. Examples included the question of what roles a scientist can and should play in the debate surrounding CE, as well as discussions about what responsibilities scientists have. Participants attempted to find answers to questions regarding how scientists should interact with political and societal spheres, and what the direction of influence is, whether scientists influence politics, or politics influences scientists. And finally, one of the most significant moral questions recurrently discussed throughout the summer school was: Supposing the decision should ultimately be made to implement CE, who decides what the 'optimal' climate is? Who has their hand on the thermostat?

## **Conclusion**

Clearly in all areas there remains much work to be done to gain a more comprehensive understanding of the implications of CE. It became apparent during the summer school that an interdisciplinary approach is essential in this process. In the words of Paul Crutzen in his seminal paper;

Scientific, legal, ethical and societal issues regarding the climate modification scheme are many. Building trust between scientists and the general public would be needed to make such a large-scale climate modification acceptable, even if it would be judged to be advantageous<sup>1</sup>

As CE encompasses not only one discipline, but a wide variety, the work towards a better understanding of its implications must also draw on information and expertise from as many different fields and perspectives as possible to enable informed decisions to be made in future. This summer school has demonstrated that such interdisciplinary exchanges can and do work. Shared knowledge is the key to understanding this complex issue, and schools such as this one encourage the establishment of a global, multidisciplinary network of academics working on CE. All those involved in the field will be given the opportunity to continue this networking process next year at the Climate Engineering Summer School 2011 in Canada.

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<sup>1</sup> CRUTZEN, PAUL J.. "ALBEDO ENHANCEMENT BY STRATOSPHERIC SULFUR INJECTIONS: A CONTRIBUTION TO RESOLVE A POLICY DILEMMA?" *Climatic Change* **77**: 211–219. doi:10.1007/s10584-006-9101-y. Retrieved 2010-3-20