

Parallel Student Presentations (16:30–18:30 on July 31, 2014)

Session 1: Politics, Law, and Impacts (Chair: Peter Irvine)

Room 1.403

16:30 – Joshua Horton, Harvard University, USA

***SRM as Emergency Response: A Counter-Critique***

16:54 – Kerryn Brent, University of Newcastle, Australia

***The Potential of the No-harm Rule to Prevent Transboundary Harm and Harm to the Global Atmospheric Commons from SRM Geoengineering***

17:18 – Daniel Heyen, Heidelberg University, Germany

***Free-rider vs. Free-driver – R&D Incentives for Environmental Technologies***

17:42 – Cush Ngongzo Luwesi, Kenyatta University, Kenya

***Tropical Forests, Climate Change and Perspectives of Geoengineering in Africa***

18:06 – Peter Irvine, Institute for Advanced Sustainability Studies, Germany

***The Impacts of SRM: The Good, the Bad, and the Uncertain***

Session 2: Natural Science Aspects of Geoengineering (Chair: Andrew Lockley)

Room 2.401

16:30 – Ellias Y. Feng, GEOMAR Helmholtz Centre for Ocean Research Kiel, Germany

***Can Artificial Ocean Alkalinization Protect Tropical Coral Habitats from Ocean Acidification?***

16:54 – Blaž Gasparini, ETH Zurich, Switzerland

***Why Do We Need to Care About Clouds When Injecting Sulphur in the Stratosphere?***

17:18 – Zhihong Zhuo, Zhejiang University, China

***Proxy Evidence for China's Monsoon Precipitation Response to Volcanic Aerosols over the Past Seven Centuries***

17:42 – Tobias Schad, Karlsruhe Institute of Technology (KIT), Germany

***Limitations of Marine Cloud Brightening***

18:06 – Andrew Lockley, Geoengineering Google Group, USA

***Geoengineering on Exoplanets***

Session 3: Ethics, Discourses, and Empirical Findings (Chair: Paul Rouse)  
Room 3.401

- 16:30 – Jeremy Baskin, University of Melbourne, Australia  
***The Ideology of the Anthropocene and the Legitimation of Geoengineering***
- 16:54 – Duncan McLaren, Lancaster University, UK  
***Justice and Geoengineering: Initial Findings from a Re-Analysis of a Public Engagement Process***
- 17:18 – Gert Pönitzsch, Kiel Institute for the World Economy, Germany  
***Informed and Uninformed Opinions on New Measures to Address Climate Change***
- 17:42 – Patrick Taylor Smith, Stanford University, USA  
***Resolving Theoretical Schizophrenia in the Ethics of SRM Research and Deployment***
- 18:06 – Paul Rouse, University of Southampton, UK  
***The Governance of the Anthropocene – How Might Global Commons be Governed in a Geoengineered World?***

## **Session 1: Politics, Law, and Impacts**

### ***SRM as Emergency Response: A Counter-Critique***

Joshua Horton, Harvard University, USA

SRM has been framed as a possible response measure in case of a climate emergency. Recently, critics have pushed back on this framing on scientific, ethical, and political grounds, questioning the plausibility of tipping points and other emergency scenarios, the legitimacy of emergency actions, and the political consequences of emergency framing. While these criticisms have merit, they overlook nuances in the emergency argument that justify continuing to treat SRM as a possible response option. Empirical evidence indicates the existence of multiple nonlinear tipping points; crossing these thresholds would entail significant risks of abrupt, large-scale, and potentially irreversible changes that would require emergency measures to avoid. Today, the only measure available to avoid catastrophic losses caused by crossing a tipping point is SRM. Turning to SRM during a climate emergency also carries risks of overly centralized power and potential authoritarianism. However, the liberal political tradition offers a broad array of institutional mechanisms designed to constrain power and otherwise mitigate such risks. Ultimately, managing the risks involved in climate emergencies, and responses to them, is an exercise in risk balancing in which the complete range of physical, economic, social, and political risks must be taken into account.

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### ***The Potential of the No-harm Rule to Prevent Transboundary Harm and Harm to the Global Atmospheric Commons from SRM Geoengineering***

Kerryn Brent, University of Newcastle, Australia

Solar Radiation Management (SRM) geoengineering poses significant risk of trans-boundary and global atmospheric harm. What role might international law play in regulating future use of SRM? In this presentation, I explore the potential of the customary 'no-harm rule' in international law to contribute to international governance of SRM geoengineering. The no-harm rule provides a legal duty on states to prevent significant environmental damage either across borders or in global commons areas. The existing literature on SRM largely assumes that the no-harm rule, due to problems with clarity and compliance, will not be effective in responding to future attempts at SRM. This presentation challenges this assumption by showing how the no-harm rule might be further developed to play an important role in managing SRM. Drawing on the constructivist logic of appropriateness, I adopt Brunnée and Toope's theory of interactional international law to explain how the no-harm rule might be developed to create a high level of legitimacy and sense of legal obligation that might pull states towards voluntary compliance. Despite being currently marginalised in SRM discourse, I conclude that the no-harm rule has an important role to play in restraining and/or managing future use of SRM.

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## ***Free-rider vs. Free-driver – R&D Incentives for Environmental Technologies***

Daniel Heyen, Heidelberg University, Germany

Environmental technologies play a key role to limit climate change. As these technologies usually are not developed yet, a positive analysis of the incentives to undertake costly R&D is key to assess their prospects. The technologies, if developed, will likely be not provided at the globally optimal level. The most prominent example of such a strategically motivated deviation from optimal behavior is free-riding and thus underprovision of the technological public good. This is, however, not the only possible strategic deviation. If private costs are sufficiently low, the country with the highest preference for the technology is the free-driver (Weitzman 2012) and dominates the outcome. The focus of this paper are the repercussions of those different strategic equilibria on R&D incentives.

I use a parsimonious setting with two periods and two heterogeneous countries to demonstrate the existence of free-riding and free-driving behavior. Building on this, I analyze the resulting incentives of the countries to contribute to a joint R&D program. I find that R&D incentives for free-rider technologies fall short of the optimal level and are monotone in the costs of technology deployment. The main finding of the paper is that this simple relationship does not hold for free-driver technologies. Here, a variety of outcomes is possible, including realization of globally undesirable R&D and the willingness of some countries to sabotage R&D programs of others.

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## ***Tropical Forests, Climate Change and Perspectives of Geoengineering in Africa***

Cush Ngondo Luwesi, Kenyatta University, Kenya

Forests are major casualties of climate change, yet they provide vital environmental functions that encompass soil and climate stabilisation, biodiversity reservoir, water and food storage as well as direct wood benefits. During the recent Holocene era (ca. 2000 yrs BP to Present), Africa has seen a reconstitution and re-extension of its dense tropical humid forests that have been depleted or largely fragmented during glaciations periods, such as the little glacial age that occurred between 15th and 18th century. However, in view of the steady warming of our planet since the industrial revolution, and owing to the drastic decrease of forest cover in Africa, forestry policy makers have an obligation to contribute to the global effort of conserving and managing forests sustainably to provide sinks for CO<sub>2</sub> and storehouses for carbon. The principle of large-scale Geo-Engineering may be acceptable as a "plan B" to supplement governments' efforts to reduce the planned GHG emissions and avoid suicidal climate mitigation and adaptation strategies. However, Climate Engineering (CE) can only be scaled up if it is too late to mitigate climate risks and adapt to the change. This paper substantiates the pros and cons of different CE options for decision-making in Africa.

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## ***The Impacts of SRM: The Good, the Bad, and the Uncertain***

Peter Irvine, Institute for Advanced Sustainability Studies, Germany

SRM may offer the potential to substantially cool the planet but it will also carry risks and at this stage little is known about its impacts. I've worked on evaluating the climate consequences of SRM for the last 5 years and in that time I've spent much time thinking about the broader impacts and implications of SRM. In this talk I'll draw on the literature on geoengineering and of climate change more broadly to describe the good, the bad and the uncertain consequences of SRM.

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## **Session 2: Natural Science Aspects of Geoengineering**

### ***Can Artificial Ocean Alkalinization Protect Tropical Coral Habitats from Ocean Acidification?***

Ellias Y. Feng, GEOMAR Helmholtz Centre for Ocean Research Kiel, Germany

Artificial Ocean Alkalinization (AOA), which was originally proposed as a carbon dioxide reduction (CDR) method, is tested in an Earth system model of intermediate complexity as a means of protecting tropical coral ecosystems from ocean acidification. AOA is deployed at a magnitude designed to keep the sea surface  $p\text{CO}_2$  and the aragonite saturation state within the safety thresholds that we selected in the Great Barrier Reef, Caribbean Sea and South China Sea regions. These simulations suggest that AOA could be a potential option for protecting coral ecosystems against ocean acidification. If AOA is deployed in these three regions for the next 80 years, this requires at least 349.2 Gt of  $\text{Ca}(\text{OH})_2$ . However, like solar radiation management, regional AOA also has a “termination effect”, mainly due to horizontal advection, that must be considered.

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## ***Why Do We Need to Care About Clouds When Injecting Sulphur in the Stratosphere?***

Blaž Gasparini, ETH Zurich, Switzerland

Already a small change in cloudiness (on the order of 1-5%) can counteract (or reinforce) the shading effects of sulphur aerosols. Unfortunately, climate models are often not able to capture the details of cloud formation and aerosol-cloud interactions. This study evaluates the options of counteracting the rising polar temperatures by stratospheric sulphur injections in the Northern Hemisphere high latitudes. 10 Mt of sulphur dioxide are emitted in a point emission source setup centred at the 100 hPa pressure level over Svalbard island (80°N,15°E). We perform simulations with the general circulation models ECHAM5-HAM, ECHAM6-HAM, and GISS ModelE.

Results from ModelE show that high latitude injections could counteract the spring and summer temperature increase caused by increasing CO<sub>2</sub> concentrations. However, preliminary results with a more realistic description of clouds in ECHAM-HAM reveal a complex pattern in surface radiation, most notably:

- a decrease in NH cirrus clouds enhances further the effect of stratospheric aerosols
- a decrease in low-level clouds over the Arctic increases the incoming solar radiation, leading to net positive radiative balance
- most changes in cloud cover can be attributed to changes in vertical temperature profiles caused by the stratospheric sulphur aerosols

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## ***Proxy Evidence for China's Monsoon Precipitation Response to Volcanic Aerosols over the Past Seven Centuries***

Zhihong Zhuo, Zhejiang University, China

The effect of volcanic aerosols on China's monsoon precipitation over the past 700 years has been studied using two volcanic indices with the Monsoon Asia Drought Atlas. Four categories of eruptions are distinguished based on their Northern Hemisphere (NH) injection, then Superposed Epoch Analysis (SEA) with a 10,000 Monte Carlo resampling procedure is undertaken for each category and individual grid. Results show a significant drying trend over mainland China from year 1 to 4 after the eruptions, and the more sulfate aerosol into the NH stratosphere the more severe this drying trend, while a minor wetting trend is observed in the years following Southern Hemisphere only injections. Results from spatial analysis show a southward movement of significant dry areas in eastern China from year 0 to 2 after volcanic perturbations that are either equal to or double the 1991 Mt. Pinatubo eruption (15T sulfate aerosols in NH), and northeast and northwest China experienced substantial droughts in years 2 to 5. These results are in agreement with SEA analysis of historical meteorological records. These illustrate the important role stratospheric aerosols have played in altering China's precipitation, and shed light on the possible effects stratospheric geoengineering may have on China's precipitation.

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## ***Limitations of Marine Cloud Brightening***

Tobias Schad, Karlsruhe Institute of Technology (KIT), Germany

With the regional model system COSMO-ART we investigate the limits of Marine Cloud Brightening in the region of Southeast Pacific. The persistent layer of stratocumulus clouds form a complex system, with processes taking place on very small scales which is difficult for atmospheric models to capture this cloud layer in a realistic way. Additionally there are still uncertainties in the outcome of MCB because of cloud aerosol interactions.

In our simulations anthropogenic emissions are taken into account and we added additionally sea salt particles to natural sea salt emissions fluxes for investigating the effects of MCB. We found that in principle additionally released particles lead to a reduction of short-wave radiation. But in areas with anthropogenic emissions the desired effect is not always achieved and shows the competition of artificially emitted particles with preexisting anthropogenic aerosols. This shows that blind seeding could be very ineffective.

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## ***Geoengineering on Exoplanets***

Andrew Lockley, Geoengineering Google Group, USA

There exists a possibility that technological civilizations on exoplanets may be undertaking geoengineering. Accordingly, this talk sets out to consider the motivations for geoengineering on exoplanets, which may have radically different climatology from our own. We consider the detection methods that may be viable to observe geoengineering on exoplanets, building on the work of other research in the field. On conclusion, we comment on the potential impact of this information for design and deployment of terrestrial geoengineering.

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### **Session 3: Ethics, Discourses and Empirical Findings**

#### ***The Ideology of the Anthropocene and the Legitimation of Geoengineering***

Jeremy Baskin, University of Melbourne, Australia

Paul Crutzen is, of course, associated with both popularising the Anthropocene concept and being among the first to make geoengineering and SRM imaginable. I argue that in the Anthropocene humanity and its planet are held to be in a critical and exceptional state. In particular the Anthropocene concept acts to legitimise a range of major and potentially highly dangerous interventions into the workings of the earth, and some deeply authoritarian state practices, none of them likely to be exercised in the interests of most of the world's people. 'Climate emergency' and SRM are particular instances of this broader framing. And this broader framing also enables other arguments to surface, including a particular account of risk, an inverted use of the 'precautionary' principle, and an attraction among the powerful to climate 'policy realism' rather than 'failed multi-lateralism'.

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#### ***Justice and Geoengineering: Initial Findings from a Re-Analysis of a Public Engagement Process***

Duncan McLaren, Lancaster University, UK

I am undertaking a re-analysis of the transcripts of public deliberative engagement undertaken by the UK Integrated Appraisal of Geoengineering Proposals project. The transcripts cover full day facilitated public engagement meetings in four UK cities. The talk will outline how participants raised and engaged with questions of justice with respect to the geoengineering techniques described. It will discuss some of the different conceptions of justice, analogues and rules of thumb applied by participants.

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## ***Informed and Uninformed Opinions on New Measures to Address Climate Change***

Gert Pönitzsch, Kiel Institute for the World Economy, Germany

Climate engineering (CE) and carbon capture and storage sub-seabed (CCS-S) are currently controversially debated options to address climate change. Our paper provides empirical evidence on the public perception of two different CE measures, namely, stratospheric sulphate injection (SSI) and afforestation, as well as CCS-S. Using data from a novel large-scale survey, we analyse the determinants of acceptance of these measures in Germany. We also provide experimental evidence on how additional information on these measures changes the respondents' acceptance. We show that the acceptance differs strongly between the three measures. Afforestation is strongly favoured over CCS-S and SSI. This ranking holds independent of the amount of information provided. For all three measures, we find that, on average, additional information decreases acceptance. However, the sign and the strength of the information effect strongly depend on personal characteristics, such as gender and risk attitude.

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## ***Resolving Theoretical Schizophrenia in the Ethics of SRM Research and Deployment***

Patrick Taylor Smith, Stanford University, USA

In my talk, I will work towards resolving a kind of schizophrenia that often characterizes theorizing about the ethics of SRM research and deployment. That is, it is often suggested that those ethical considerations that ought to govern SRM research and those that ought to govern SRM deployment radically diverge. Some views imply that research is morally permissible even when deployment would not be. Conversely, other views imply that there are cases—emergencies in particular—where SRM would be justified even though active research programs would remain morally problematic.

It is undeniable that research and deployment are distinct actions; each will require its own analysis. Yet, they are clearly related, and such a fundamental divergence is unsettling. I argue that my view—which founds the evaluation of SRM on the moral requirement to avoid global and intergenerational domination—can resolve this split. I accomplish this in two steps. First, I identify the key elements that lead to the divergence: the problems of power and political control. Second, I show that—on my view—the strategies for the appropriate normative resolution of these problems for deployment and research are mutually reinforcing and necessary for the justification of the other.

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## ***The Governance of the Anthropocene – How Might Global Commons be Governed in a Geoengineered World?***

Paul Rouse, University of Southampton, UK

There are no comprehensive governance theories for the global commons (GC) when they can be intentionally changed at the level of the Earth system. Consent, consensus and concord provide a mechanism through which dialogue about risk, uncertainty, ambiguity and ignorance can be incorporated into the construction of their governance. These processes of negotiation will create a tapestry of potential governance vectors, muddying the waters of what has previously been interpreted as a clearer institutional, or regime, model of GC governance, aligning more closely to real-world experience and allowing divergent contexts, public values, disciplinary perspectives and stakeholder interests to come to bear on governance processes, opening up access to plural interpretations of how the GC might be governed.

This interpretation allows for a more complete understanding of stakeholder roles and governance processes, recognizing that what we don't know is as important as what we do know and that no matter how much we think we know, there are no grounds for complacent confidence in the face of Rumsfeld's infamous 'known knowns'.

Whether these approaches are in play is the subject of the empirical research.