



## Cracking the code: how discursive structures shape climate engineering research governance

Miranda Boettcher

To cite this article: Miranda Boettcher (2020) Cracking the code: how discursive structures shape climate engineering research governance, *Environmental Politics*, 29:5, 890-916, DOI: [10.1080/09644016.2019.1670987](https://doi.org/10.1080/09644016.2019.1670987)

To link to this article: <https://doi.org/10.1080/09644016.2019.1670987>



© 2019 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group.



[View supplementary material](#)



Published online: 02 Oct 2019.



[Submit your article to this journal](#)



Article views: 1137



[View related articles](#)



[View Crossmark data](#)



Citing articles: 5 [View citing articles](#)

# Cracking the code: how discursive structures shape climate engineering research governance

Miranda Boettcher <sup>a,b</sup>

<sup>a</sup>Institute for Advanced Sustainability Studies e.V. (IASS), Potsdam, Germany; <sup>b</sup>Freie Universität Berlin, Berlin, Germany

## ABSTRACT

There is increasing interest in developing anticipatory governance of climate engineering (CE) research. Discourse is the source code with which contested futures are written, shaping how future governance options can be imagined, designed and institutionalized. ‘Cracking the code’ underpinning the CE research governance debate can, therefore, help anticipate and critically reflect upon the ongoing constitution of governance. I present a sociology-of-knowledge-based discourse analysis (SKAD) of a series of interviews with governance experts from the US, the UK and Germany about a proposed Code of Conduct for climate engineering research. I illustrate how – by shaping what is defined as the object(s) of governance, why governance is considered necessary, and who is assigned the authority to govern – the underlying discursive structure of a given governance debate can shape governance development.

**KEYWORDS** Discourse analysis; sociology of knowledge; anticipatory governance; climate engineering; expert interviews

## From discursive structure to anticipatory governance

Discussions about governing climate futures have become even more complex with the idea of climate engineering (CE), which includes a set of heterogeneous proposals for intentionally intervening into the global climate system to reduce the risks of climate change (Shepherd 2009)<sup>1</sup>. The idea of intentional, large-scale manipulation of the global climate has been called a ‘quintessential anticipatory governance challenge, wherein the perils and promises associated with a suite of CE options remain uncertain, contested and to a large extent unknowable’ (Gupta and Möller 2019, p. 481). There is, therefore, increasing interest in developing ‘anticipatory’ – that is, future-oriented, reflective, upstream-focused – governance of CE research and development (Stilgoe *et al.* 2013). The underlying discursive structure of a given governance debate has a constitutive effect on how future governance options can be imagined,

**CONTACT** Miranda Boettcher  [miranda.boettcher@iass-potsdam.de](mailto:miranda.boettcher@iass-potsdam.de); [miranda.boettcher@gmail.com](mailto:miranda.boettcher@gmail.com)  
 Supplemental data for this article can be accessed [here](#).

© 2019 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group.  
This is an Open Access article distributed under the terms of the Creative Commons Attribution-NonCommercial-NoDerivatives License (<http://creativecommons.org/licenses/by-nc-nd/4.0/>), which permits non-commercial re-use, distribution, and reproduction in any medium, provided the original work is properly cited, and is not altered, transformed, or built upon in any way.

designed and institutionalized. However, to date, there has been little empirical analysis of the discursive structure of the emerging CE research governance debate, and a lack of corresponding discussion of how this debate shapes CE governance itself.

Some preliminary work has traced how the development of CE definitions has had a *de facto* governance effect on CE research (Gupta and Möller 2019) and has explored how underlying rationales for CE governance may shape *de jure* governance development (Jinnah 2018). Building on this work, here I present an empirical sociology-of-knowledge-based discourse analysis (SKAD) to better understand how CE research governance options are being shaped by discursive structures (Keller *et al.* 2018). Specifically, I conducted and analysed a series of interviews with governance experts from the United States, the United Kingdom and Germany about their views on one specific CE governance proposal: the Code of Conduct for Responsible Climate Engineering Research (Hubert 2017). My analysis illustrates how – by shaping what is defined as the object(s) of governance, why governance is considered necessary, and who is assigned the authority to govern – the underlying discursive structure of a given governance debate has not only ongoing *de facto* governance effects, it also shapes how future *de jure* governance options can be conceptualised.

The next sections briefly introduce the Code of Conduct and situate my analytical framework in the wider work on CE discourse analysis. I then outline my methods and analytical approach, before reporting my results and discussing their implications for the development of CE research governance.

### Proposed code of conduct for responsible climate engineering research

CE research presents a novel spectrum of upstream governance challenges ranging from *enabling* research into the prospective benefits of CE approaches to *restricting* the potential environmental and socio-political risks associated with such research. Several scholars have indicated that existing national and international governance structures are not fully suited to meeting these future-oriented challenges (Craik *et al.* 2013, Armeni and Redgwell 2015, Schäfer *et al.* 2015, Morrow 2017). Therefore, recently there has been an increasing focus on the need for upstream, anticipatory forms of CE governance which fulfil both enabling and restrictive functions, and are flexible enough to enable linkages between different stages of CE research at various institutional levels (Stilgoe *et al.* 2013, Bellamy 2016, Chhetri *et al.* 2018, NAS 2018, Jinnah *et al.* 2018). The groundwork for such governance frameworks has previously been laid out in broad principles (Asilomar Scientific Organizing Committee 2010,

Rayner *et al.* 2013), and a wide range of governance proposals have been conceptualised (Cf. Reynolds 2019).

One proposal which stands out as particularly well developed in this landscape is the Code of Conduct for Responsible Climate Engineering Research (Hubert and Reichwein 2015, Hubert 2017). The Code includes a set of principles and practices for responsible CE research and provides a set of practical guidelines for the assessment of outdoor CE experiments. It also lays out guidance on public participation, research monitoring and the public provision of information on CE research (Hubert 2017)<sup>2</sup>.

The Code further aims to:

Provide further practical guidance on the responsible conduct of geoengineering research and development [...] It is designed as a voluntary instrument, though one that is based upon existing legal sources, including general principles, rules of customary international law, treaty-based rules, regulations, international decisions, and policy documents. The guidance provided in the Code is global in scope, but relevant for various State, sub-State and non-State actors [...]. The Code seeks to balance three main functions of [CE] research governance: to prevent and minimise the risk of environmental and other harms; to promote responsible geoengineering research with a view to better understanding the potential efficacy, benefits, and risks of proposed techniques; and to enhance legitimacy. (Hubert 2017, p. 4)

The Code has explicitly been presented as a living document which is being developed within an ‘ongoing process of engagement’ (Hubert 2017, p. 21). As such, in 2016 the Geoengineering Research Governance Project (GRGP) was launched by the University of Calgary, the Institute for Advanced Sustainability Studies (IASS), and the University of Oxford to further develop the draft Code of Conduct by incorporating input from a variety of stakeholders. Here, I detail the results of one part of the GRGP project: A SKAD discourse analysis of a series of interviews about the Code carried out with governance experts from the United States, the United Kingdom and Germany. Mapping one sphere of the discursive structure within which the Code is emerging provides a unique opportunity to highlight the potential shaping effects of discursive structures on the continuing development of CE governance.

### **A structural framework for CE discourse analysis**

The social science literature on CE includes a range of contributions that focus on analysing different aspects of CE ‘discourse’ (Belter and Seidel 2013, Oldham *et al.* 2014). However, these analyses are often based on different definitions of what ‘discourse’ is, and what the analysis aims to achieve. These contributions can be broadly clustered into two overarching groups. The first group of contributions are based on an agency-driven

concept of ‘discourse’ as a public debate carried out by strategic actors who interact with each other. The purpose of analysing a given discourse is to identify the strategies employed by actors to communicate their beliefs or advance their interests on a certain issue (Kerchner and Schneider 2006). Most agency-derived interventions discuss how framing (Scholte *et al.* 2013, Huttunen and Hildén 2013, Markusson 2013, Porter and Hulme 2013, Huttunen *et al.* 2014, Corner and Pidgeon 2015, Raimi *et al.* 2019), metaphors (Nerlich and Jaspal 2012) and argumentative strategies (Sikka 2012, Surprise 2019) shape CE governance discourse.

The second pool of work, and the one to which I contribute here, uses a structurally derived concept of ‘discourse’, defined as an underpinning system of power/knowledge. This structural lens illuminates shaping effects of discursive structures – as an interrelated system of ideas, concepts and categories – on what it is possible for social actors engaged in a given debate to say. Rather than being completely free agents, this approach assumes that ‘in performing their articulations, social actors draw upon the rules and resources that are available via the present state of a given discursive structuration’ (Keller *et al.* 2018, p. 20). The aim of a structurally derived discourse analysis then is to understand the underlying power and/or knowledge structures within which social meaning is being constituted (Keller 2011, Keller *et al.* 2018). For example, some existing analyses show how divergent concepts of responsibility and uncertainty shape competing approaches to governing CE (Matzner and Barben 2018), explore the discursive boundaries that determine what is considered legitimate CE knowledge (Cairns 2016), and map how certain discursive structures make it possible for CE research to be legitimately called for (Boettcher 2012, Uther 2014, Harnisch *et al.* 2015) or criticised (Anshelm and Hansson 2014).

One specific structurally derived approach to discourse analysis is the sociology of knowledge approach to discourse (SKAD), in which discursive structures are the systemic, historically contingent, relatively robust manifestation of power/knowledge relations within a given discursive sphere. The SKAD approach posits that there is a difference between utterances made by individuals and the underpinning structures that shape such utterances. It thus aims to identify such underlying structures to highlight the role they play in shaping social reality (Keller 2011, Keller *et al.* 2018). In a governance debate, these structures correspondingly shape what type of governance objects, subjects and rationales can be thought of and discussed by social actors (Stielike 2017). Discursive structures, therefore, have an enabling effect on *de facto* governance by constituting socially meaningful governance objects, subjects and rationales. Correspondingly, they have a restrictive effect on *de facto* governance by limiting what it is possible to know and say about a given issue in a particular societal context. Furthermore, discursively constructed, societally meaningful objects,

subjects and rationales can solidify into formal institutional arrangements and infrastructures.<sup>3</sup>

Premised on this understanding of the performative link between discursive structures and governance development, the following analysis aims to identify the structures underpinning one specific sphere of the CE governance debate (i.e. that within three of the OECD countries in which CE research is taking place), and critically discuss the shaping effects they may have on the future development of the Code of Conduct and CE research governance more generally within those countries.

## Methods and approach: reverse-engineering discursive structures

### *Data collection: interviews*

In order to identify the discursive structures underpinning the development of the Code of Conduct, I conducted 22 semi-structured interviews. The interviewees consisted of a range of governance experts at the science/policy interface, including current and former government employees, as well as governance experts from academia and civil society organisations (for an anonymised list of interviewees, see Supplementary Table I). The interviewees were all from the United States, the United Kingdom and Germany as these three countries are currently considered to be leaders in CE research, with relatively well-developed debates on the complex issues related to the governance of CE (Harnisch *et al.* 2015). As such, the group of interviewees is not representative of the broader CE governance debate, and therefore the discursive structures I have identified do not and should not exclusively shape the development of the Code or other forms of CE research governance. Rather, this analysis maps *one* important set of discursive structures shaping *one* emerging proposal on CE research governance. Clearly, there are many more discursive structures relevant for CE governance development, such as those underpinning voices from developing countries, which have recently been identified as underrepresented in the literature (Biermann and Moller 2019). Mapping wider discursive structures in the debate is a critical focus of future research.

Interviewees were asked 15 open-ended questions, divided into three blocks. The first block was designed to elicit information on the interviewees' understandings of the concepts 'CE', and 'governance' and to explore their general opinions on the need for governance of different types of CE research. The second block sought to discuss the ways in which governance of other emerging technologies has developed and the roles of different stakeholder groups in the development of governance. The final block focused on the potential advantages and disadvantages of the implementation of a Code of

Conduct for CE research. All interviews were recorded and transcribed for analysis.

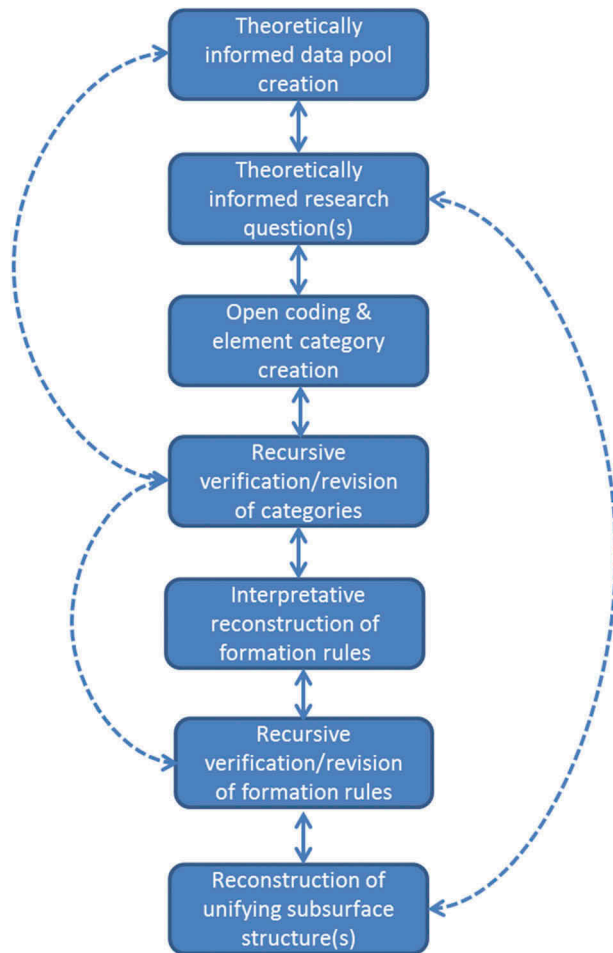
### **Analysis: inductive coding and iterative structural mapping**

The SKAD discourse analysis approach employed in this study is designed to systematically reverse-engineer a given discursive structure from discursive outputs (e.g. newspaper articles, interview transcripts) (Keller *et al.* 2018). Following the SKAD approach, I first created a data pool of discursive products (in this case interview transcripts), and a set of theoretically informed research questions to guide the search for elements and rules of discursive formation. These questions included: *What is being constructed as the object(s) of governance? How is the term governance being defined? What demand rationales are structuring calls for CE research governance? What authoritative speaker positions are available within the structure of the CE research governance discourse?* I then undertook a preliminary analysis of the material to identify how the discursive elements' 'governance terms and objects' (what), 'demand rationales' (why), and 'speaker positions and governance roles' (who), appeared in the transcripts. I then systematised the transcribed interview data for analysis through a process known as 'open coding,' which involves inductively organising elements of the transcripts into categories with the help of the qualitative text analysis program MAXQDA (Hardy *et al.* 2004). The next step involved identifying recurring formation rules with which discursive elements were related. These included patterns of differentiation, relationships of equivalence and contrariety, and fundamental oppositions between elements of the discourse (Torfing 1999, Diaz-Bone 2006, Keller *et al.* 2018). This was a recursive process in which preliminary findings were checked against further empirical material to ensure that the formation rules identified applied consistently across the data pool. This iterative analytical approach is outlined in [Figure 1](#) (cf. Diaz-Bone 2006, Keller *et al.* 2018). The end result of this analysis was a map of discursive structures shaping governance terms and objects, roles and rationales in this sphere of the CE research governance debate. The results and their potential implications for CE governance development are detailed in the following section.

## **Results: discursive structures shaping the what, why and who of CE research governance**

### **Govern what?**

Discourses 'systematically form the objects of which they speak' (Foucault (1969(2002)), p. 54). This is especially important in relation to emerging technologies, as the way such technologies are discursively 'formed as



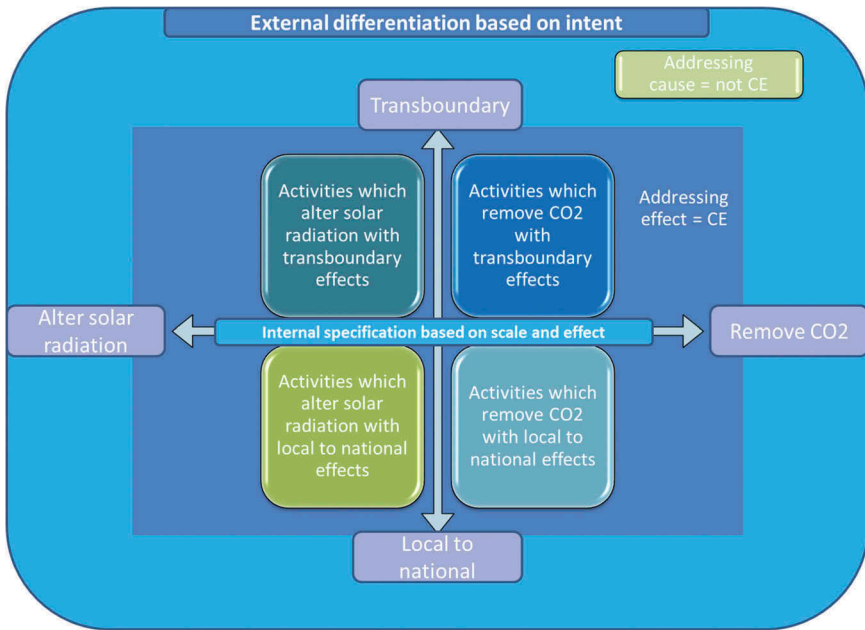
**Figure 1.** Approach to mapping discursive structures.

objects' early on affects the way they are governed, and the way they are governed affects the way technologies are, in turn, further conceptualized and developed (Cf. Gupta and Möller 2019). Therefore, the discursive formation of the object(s) which should (not) be governed has the potential to shape the development of the Code and other CE governance mechanisms. The question that guided this section of the analysis was therefore: *'What is being constructed as the object(s) of governance?'*

The analysis of interviewees' definitions of the concept of CE resulted in the identification of systematic external differentiation and internal specification patterns which formed differing boundaries of the object(s) of governance.

On the one hand, patterns of external differentiation were evident in the way some defined the broad concept of CE by drawing lines between what





**Figure 2.** Formation of objects in the CE governance debate. External differentiation according to intent. Internal specification according to scale and effect.

CE is and what it is not. Interviewees established this differentiation by referring to other ways to deal with climate change (i.e. societal transformation or emissions mitigation), thereby defining CE as a governance object through its relationship to external objects. The categorization of what is (or is not) CE was largely related to intent – interventions that ‘deal with the underlying cause of climate change’ (e.g. reducing emissions) were considered external to CE, whereas activities that aim to ‘mediate the effects of climate change’ fell within the boundaries of the CE object.

In addition, underlying patterns of internal specification underpinned the way some interviewees defined CE. In other words, definitions of *types* of CE approaches were related to the scale of their direct impacts (ranging from local to transboundary) and their primary effect (altering solar radiation (SRM) or removing atmospheric CO<sub>2</sub> (CDR)) (see Figure 2).

The implications of these two types of discursive categorisation for governance conceptualisation were evident in that those interviewees who used patterns of external differentiation tended to argue for the continued use of the umbrella term CE for governance purposes, while those interviewees who drew upon patterns of internal specification tended to argue against the continued use of the umbrella term CE when designing CE research governance (see Table 1).



**Table 1.** External differentiation and internal specification of CE for governance purposes.

| Discursive categorization   | Examples  | Key Arguments   |
|---|---|---|
| <p><b>External differentiation</b> to argue for umbrella term for governance purposes.</p>  | <p>I understand that there are people who want to restrict the definition of geoen지니어ing just to SRM, and not also include CDR; I think that the two technologies are very different. [...] the two classes of technologies are extremely different, for different reasons. They present different risk profiles, and, um, but nonetheless I think that there is already a kind of a sense that when we are talking about [CE], let's talk about both of these different kinds of things that intervene in the climate system. (Interviewee 04)</p>   | <ul style="list-style-type: none"> <li>• Despite the fact that the two sets of technologies have different risk profiles, the character and intent of both sets of technologies remain the same; intentional intervention into the climate system to mitigate the effects of climate change.</li> <li>• Having a label for the larger category of intentional action is necessary for developing policy. We need a workable label we can use in order to invoke broader policies or practices that can make the Earth a better place.</li> <li>• It is easier to have a broad, catch-all term to avoid definitional disagreements during policy development processes.</li> </ul> |
| <p>I use the broadest definition of geoen지니어ing: Any large-scale technology intervention in systems to do something about the climate situation, and, I think there's some benefit to that because, although we do need to look at technologies one by one, and assess their risks, their risk-profiles, their positive characteristics, we also have to think about technology in particular ways. Any large-scale intervention seems to have a character to it that deserves at least some joint categorization. (Interviewee 21)</p> | <p>So, while, in detail, especially from a technical standpoint, putting a label on anything, any several things as either in or outside of [CE] has its flaws, if we don't have a label for it, we don't have a way for describing it in terms of developing the policies that we need. Because that's what it really boils down to at the end of the day. It's not just understanding and describing what it is we are doing for some technical reason, but actually having something that we can utilize in order to invoke policies or practices that can make the earth a better place. (Interviewee 22)</p> |   |
| <p>Well, the term has its problems, as we are all aware, but we seem to be sort of stuck with it I suppose. [...] Unless someone is gonna come up a new term that everyone is going to accept, and that seems unlikely, given the various terms that are being banded about and no one's really accepted – not a substantial number at least – any of them, so I think a fairly broad term about CE needs to be used [...] otherwise it could become very messy (Interviewee 08)</p>  |   |   |

(Continued)

Table 1. (Continued).

| Discursive categorization  | Examples  | Key Arguments  |
|--|---|--|
| <p><b>Internal specification</b> to argue against umbrella term for governance purposes.</p> | <p>I think if we start trying to set very strict limits around what is [CE] and what isn't based on the fact that the definition itself is very broad, it becomes quite a difficult discussion. And I think to some extent, that's why it is very difficult to come to a simple view about how best way to regulate [CE] research because there is such a broad definition [...] It is very difficult if you were trying to design a single regulation that would cover all [CE] activities. I think it would be unlikely to get anywhere beyond some fairly top level statements as to, you know what's acceptable or not. (Interviewee 11)</p> <p>[CE] is a useless phrase, there's almost nothing useful you can say about the highly diverse group of technologies which are often grouped together as [CE]. So at the very, very minimum you need to break things down into carbon-removal and SRM techniques, because the implications and the applications are so different. And that's expressed most clearly when we talk about governance (Interviewee 05)</p> <p>The CO2 removal I think is, ah, I know it has also been lumped into the category [CE], but my gut sense is that I don't know if that makes sense to also call that [CE], because I think it is quite different, and I think probably continuing to simply call that carbon removal is better. So that we can start distinguishing these things more. Because they are very different, and I think to have a better governance discussion of it, it is actually good to start using terms that are more distinguishing among the types (Interviewee 07)</p> <p>I think having an overarching term in this [governance] discussion is actually counterproductive. We have two very different sets of techniques, um, those for removing carbon from the atmosphere, and those for potentially reflecting sunlight back to space, that come along with very different issues. And even within those individual overarching terms, there are very different issues related to the individual technologies. So this summing up into the large term [CE], I think is actually counterproductive (Interviewee 12).</p> | <ul style="list-style-type: none"> <li>● Implications and applications of the range of CE technologies are too diverse to be able to say anything useful about their governance as an aggregate group.</li> <li>● Lumping CDR into the CE definition muddies the waters: It is difficult to impossible to design a governance framework that would equally restrict/enable research into CDR and SRM – there is a need to (at least) differentiate between these groups of approaches for governance purposes.</li> <li>● Having an overarching term is counterproductive for effective research governance, only the most general of governance principles could sensibly be agreed upon as applying to the whole range of CE research activities.</li> </ul> |

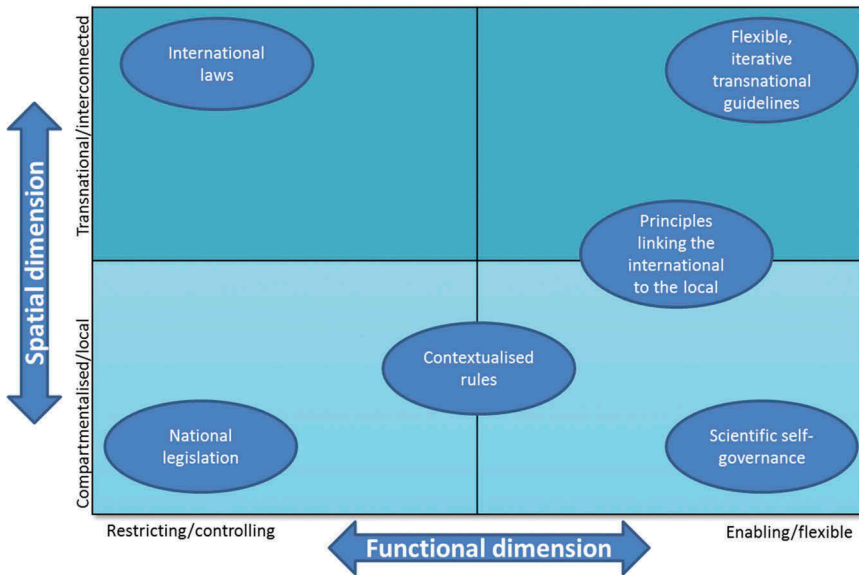
These findings have a range of potential implications for the development of CE governance in general, and for the Code of conduct specifically. On the one hand, if patterns of external differentiation related to intent became central to definitions of CE for governance purposes, the governance object 'CE' would be singular. However, the boundaries of this unified object of governance would be extremely broad, and governance frameworks would correspondingly need to be flexible and adaptable to the wide range of CE research activities which fell within such an encompassing definition. On the other hand, if patterns of internal specification related to scale and effect became fundamental to definitions of CE for governance purposes, the governance objects would be pluralized. As the boundaries of these multiple objects of governance would be much narrower, governance mechanisms would need to be more specific to individual CE research activities.

Currently, the proposed Code of Conduct is written in a way that makes it flexible and adaptable enough to be applied to the broad range of CE research activities that could be unified into single governance object by continued patterns of external differentiation. If, however, patterns of internal specification led to the solidification of multiple objects of CE research governance based on the intersection of the scale and effect of each research activity, specific versions of the Code could conceivably develop to apply more explicitly to each of the resulting governance objects.

### ***What is 'governance?'***

The term 'governance' has been used in the field of CE to refer to concepts ranging from international regulations restricting CE deployment to informal norms guiding individual research practices. The broad nature of the term can lead to misunderstanding about the need for 'governance' of CE. Understanding the discursive structures shaping the ways in which interviewees conceptualise governance is essential to understanding their evaluation of the need for and potential effectiveness of the proposed Code of Conduct, as well as the way in which they envisage its implementation. The question that guided this section of the analysis was therefore: *'How is the term governance being defined in relation to the Code?'*

My analysis showed shared discursive structures underpinning the way in which definitions were conceptualised by interviewees. The diversity of definitions were positioned along either functional (controlling/restricting versus enabling/allowing flexibility) or spatial (local/compartimentalised versus transnational/interconnected) spectrums (see [Figure 3](#)). This positioning was often done by means of contrast in relation to opposing positions on one or more of the spectrums. The following examples illustrate how interviewees positioned 'governance' along these two spectrums:



**Figure 3.** Spatial and functional positioning of CE governance definitions.

- **Functional:** ‘Well, ideally, it is something that has got some legal backing, but there is soft governance, and there are voluntary codes of governance ... it is a spectrum. I think I, being a policymaker and a law-maker, believe that things should be legally underpinned, and that it should be a binding legal framework’ (Interviewee 03).
- **Spatial:** ‘The governance would either be by the Environment Agency, for large-scale things, or the local authority for smaller-scale things [...] local authority control for most things, probably, but you could imagine, if there were transboundary effects, then maybe it needs something international’ (Interviewee 01).
- **Functional and spatial:** ‘Governance should be national and international. I mean, I think that if you don’t have national guidelines, you know, the full gamut from voluntary guidelines to more robust sort of forms of governance at the national level, then the sub-national actors will back-fill it, and then you get a chaotic environment, which is not good. [...]’ (Interviewee 04).

These findings have implications for the development of CE research governance in general, and the proposed Code of Conduct in particular. Generally, highlighting the relative positioning of definitions in a given debate can aid in understanding which governance developments may be appropriate (i.e. imaginable, possible) within the spatial and functional dimensions of the resulting governance space. Concretely, these findings

indicate that the spatial and functional dimensions of governance definitions underpinning calls for CE research governance may influence the development of pathways towards the implementation of the Code within this sphere. The results suggest that if the CE research governance debate centres around governance definitions located in the upper left of [Figure 3](#), the Code may inform the development of binding international regulations on CE research. A dominance of governance concepts in the lower left would indicate that the Code may be used to inform the development of binding national or sub-national legislation. A consolidation of governance concepts positioned in the upper right may indicate the possibility of adoption of principles from the Code as a set of non-binding translational guidelines for responsible research. If the debate, conversely, focuses on governance definitions located in the bottom right corner of [Figure 3](#), the Code may rather develop as the basis for systems of scientific self-governance.

However, this particular sphere of the CE research governance debate currently includes a wide range of understandings of governance. Correspondingly, emerging governance frameworks appropriate to these varying definitions would be both functionally flexible and adaptive to local, regional and international governance spatial contexts. As the draft Code is designed to provide an adaptive, flexible basis for developing a range of governance mechanisms on different levels and fulfilling different functions, it would seem to be well positioned to form the basis for multi-layered CE research governance developments imaginable within the current heterogeneous definitional debate.

### **Why govern?**

Differing logics underlying calls for CE governance will have varying implications for the perceived usefulness of the proposed Code of Conduct, and the ways in which it may eventually be institutionalised. This section relies heavily on [Jinnah \(2018\)](#), which illuminates how possibilities for institutional design can be shaped by the nature and constellation of ‘demand rationales’ for the governance of emerging issues. The question that guided this section of the analysis was therefore: ‘*What demand rationales are structuring calls for CE research governance?*’

An overview of interviewees’ governance demand rationales (i.e. why CE research should be governed) is provided in the first column of [Table 2](#). The range of demand rationales within this sphere of the CE debate delineates the boundaries of the discursive space within which calls for CE research governance can be made. Therefore, arguments for the governance of CE research which do not locate themselves within the boundaries of this

**Table 2.** Demand rationales for CE research governance.

| CE research governance is needed for the purpose of:  | Examples  | Underlying demand rationale   |
|---|---|---|
| <b>Protecting</b> the environment and human health from potential harm from CE research         | [Governance is needed] to ensure that there is a level of protection for, you know, not only for human societies but also for wildlife and natural systems, natural processes. (Interviewee 11)   | <b>Functional:</b> Governance as rational problem solving, driven by utilitarian cost-benefit calculations and risk management concepts.  |
| <b>Reducing the risk</b> of unintended (environmental and societal) consequences of CE research | I think there needs to be some level, inherent level of governance that makes sure that the research that we are doing either locally, nationally, regionally, internationally is within some set of controlled parameters, so that, again, we obviate or we at least ameliorate the possibility of unintended consequences. (Interviewee 22)   |   |
| <b>Encouraging and enabling</b> 'useful' research   | The advantages [of research governance] are that scientists and scientific organisations and countries would have a green light to go ahead with useful research, which I think is necessary. (Interviewee 14)  |   |
| <b>Averting conflict</b> as a result of CE research   | Some categories of geoeengineering research, since it does cover a lot of different things, ah, could probably work under a non-binding governance regime, whereas others at some point will definitely need some binding measures where there's compliance and, uh, behaviours of actors, involved in the research potentially could start to suffer conflicts of interest. (Interviewee 16) | <b>Strategic:</b> Governance to protect (national) interests, particularly relating to security and economic stability, and motivated by a desire to influence (change or maintain) the balance of power. |
| <b>Preventing</b> 'rogue' CE research against the will/without the knowledge of others          | At the same time it could put some appropriate constraints on others who wanted to ... who might be a little less conservative and a little bit more aggressive about, um, some large-scale research. (Interviewee 07)  |   |
| <b>Preparing:</b> Someone is going to continue with CE research, 'we' need to be prepared       | It is quite clear in the end that someone is gonna do something and if at that point all we've done is say it shouldn't happen, then we're not really any further ahead in terms of having any influence on the way in which decisions are being made. (Interviewee 11)   |   |

(Continued)



**Table 2.** (Continued).

| CE research governance is needed for the purpose of:                                 | Examples  | Underlying demand rationale  |
|--|---|--|
| <p><b>Facilitating</b> inclusive global discussions about CE research governance</p> | <p>So that's what I mean by the kind of a softer governance that goes around, it is much more about the way in which the society engages with geoeengineering as a concept and discusses which activities should be regulated and how (Interviewee 11)</p>  | <p><b>Normative:</b> Governance to strengthen existing norms or create new ones, motivated by a desire to ensure/increase global justice and equality.</p> |
| <p><b>Setting shared norms</b> for CE research</p>                                   | <p>So this is largely I think at the moment, um, an exercise in norm-building. [...] It's about making sure we spark appropriate conversations inside scientific circles, um, with appropriate oversight from publics and from, you know, regulatory agencies that have some mandate when it comes to scientific investigation (Interviewee 21)</p>                 |  |
| <p><b>Ensuring</b> CE research and development is conducted responsibly</p>          | <p>I think that it is critically important that the role of governance is that it allows for a sort of a better pathway towards responsible development (Interviewee 04)</p>  |  |
| <p><b>Creating</b> transparency about CE research</p>                                | <p>I mean, the advantages to having a code of conduct are that they are a transparent statement of intent about how an entity is going to approach the governance of research. So, that, that's the desirable thing (Interviewee 05)</p>  |  |
| <p><b>Establishing</b> (democratic) legitimacy for CE research</p>                   | <p>I think that, in order to create legitimacy for these kinds of technologies, the further up-stream you go with building social consensus, the more likely it is you are able, finally, to have a solution that is, you know, socially acceptable, that is, that is likely to be adapted to ethical and other concerns societies might have. (Interviewee 02)</p> |  |



discursive space by adhering to one or more of these underlying demand rationales may be considered less authoritative or legitimate.<sup>4</sup>

Jinnah (2018, p. 5) proposes a framework to link empirical findings on demand rationales to governance design principles. I assessed the extent to which the rationales I had identified underpinning calls for governance of CE research empirically supported the three (non-mutually exclusive) conceptual demand rationale categories suggested by Jinnah:

- The **functional rationale** underscores that governance involves efforts towards rational problem solving, and which are driven by utilitarian cost-benefit calculations and risk management concepts (Jinnah 2018, p. 6). I correspondingly categorized demands for the governance of CE research identified in the interview transcripts as belonging to this rationale if they emphasised the need for governance of CE research to either reduce the risk of (environmental and societal) harm, and/or to ensure the utility of CE research activities.
- The **strategic rationale** emphasises that governance is driven by the need to protect (national) interests, particularly relating to security and economic stability, and motivated by a desire to influence (change or maintain) the balance of power (Jinnah 2018, p. 6). I categorised demands for CE research governance as being underpinned by this rationale if they focused on conflict prevention and interest balancing.
- The **normative rationale** posits that governance reflects a desire to strengthen existing norms or create new ones, and is motivated by a desire to ensure/increase global justice and equality (Jinnah 2018, p. 6). I categorized governance demands as normative if they accentuated the promotion of participation, transparency, legitimacy and responsibility.

Table 2 summarizes the categorization of demands for the need for CE research governance according to these rationale categories, and provides examples of each type from the data pool, showing that a slightly wider range of reasons for CE research governance that adhered to the normative demand rationale (five types of normative arguments versus three functional and three strategic) were identified in the interview data. This may indicate a slight trend towards a structural dominance of normative rationales for CE research governance in this discursive sphere.

Applying insights from theories of global governance, Jinnah suggests a given constellation of functional, strategic and normative demand rationales can inform the development of control mechanisms and the suitable degree of polycentricity when designing governance mechanisms for emerging technologies. If demands predominately adhere to a **functional** rationale, governance suited to meeting these demands would likely be

technocratic in nature; if demands are largely **strategic**, the demand-based framework would suggest hegemonic governance structures; and if **normative** demands dominate, democratic governance structures focused on enhancing legitimacy and inclusiveness may be more suitable (Jinnah 2018, p. 7). Further, if all three types of demand rationales are equally present, strongly polycentric governance architecture that could differentially address these demands in different forums may be most appropriate. Conversely, if one type of demand rationale clearly dominates calls for the governance of a given technology, the framework suggests that a centralized governance structure may correspondingly be more suitable to satisfy these demands (Jinnah 2018, p. 8).

Table 3 outlines the relationships between demand rationales and the resulting implications for governance and indicates the type of CE research governance development suggested by applying this demand-based theory of governance design to the demand rationale constellations I identified. Given that my analysis revealed that all three types of governance demand rationales are present in the calls for CE research governance, the demand-based theory of governance design would suggest that a strongly polycentric governance structure would be most appropriate. The fact that a slightly larger range of normative rationales were identified suggests that democratic governance structures focused on enhancing legitimacy and inclusiveness in decision-making on CE research could be most suitable to address the governance demands present in this sphere of the CE discourse.

The potential implications of these findings for the perceived usefulness of the proposed Code of Conduct, and the ways in which it may eventually be adopted and/or institutionalised are two-fold. Firstly, opinions about the usefulness of the Code differ based on the underlying governance demand rationale. The Code was perceived to be able to fulfil normative demand rationales, such as instigating inclusive discussions about CE research, setting shared norms among researchers and creating transparency about

**Table 3.** Implications of demand rationales and constellations for principles of CE governance design. Adapted from Jinnah 2018.

|                   |            | Demand constellations               |                                       |                            |
|-------------------|------------|-------------------------------------|---------------------------------------|----------------------------|
|                   |            | Heterogeneous                       | Moderately heterogeneous              | Homogeneous                |
| Demand rationales | Functional | Technocratic & strongly polycentric | Technocratic & moderately polycentric | Technocratic & centralized |
|                   | Strategic  | Hegemonic & strongly polycentric    | Hegemonic & moderately polycentric    | Hegemonic & centralized    |
|                   | Normative  | Democratic & strongly polycentric   | Democratic & moderately polycentric   | Democratic & centralized   |

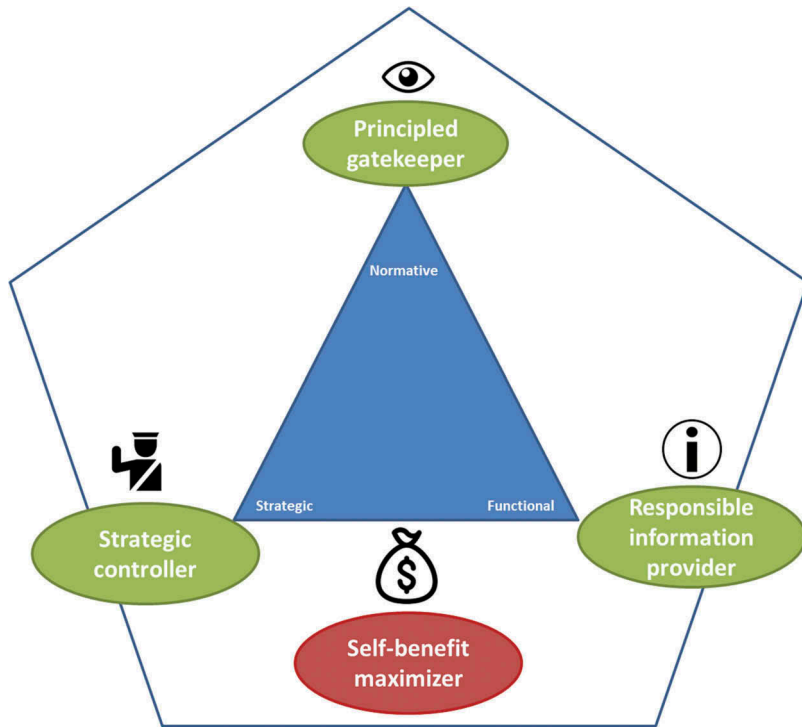
the way in which research is being carried out. It was, however, posited as being less able to fulfil most of the strategic and functional demand rationales unless it was institutionalised as the basis of a more binding governance mechanism. This suggests that if further research indicates that the wider CE research governance discourse is structured by a normative demand rationale, as these first results suggest, the Code could form the basis of informal governance mechanisms to enhance legitimacy and inclusiveness in decision-making on CE research. Secondly, the indication that a polycentric governance structure would be most appropriate within the structure of identified demand rationales suggests the possibility of the development of pluralistic pathways towards the implementation of the Code in a diverse range of fora on sub-national to international levels.

### **Who governs?**

The underlying structure of a given discursive sphere not only defines the boundaries of what is it is legitimately possible in a given policy space, but also provides a limited range of speaker positions which can be adopted by social actors who are able to authoritatively engage in the discourse itself (Keller *et al.* 2011, 2018). What types of speaker positions are available in the CE research governance discourse and which governance rationales and roles are associated with them is relevant for understanding how different types of actors can be expected to enter the CE research governance debate generally, and engage with the Code specifically. The question that guided this section of the analysis was therefore: *‘What authoritative speaker positions are available within the structure of the CE research governance discourse?’*

My analysis identified four speaker positions available within the structure of this sphere of the CE governance discourse: principled gatekeeper; responsible information provider; strategic controller; self-benefit-maximizer. Each speaker position is bounded by a distinct constellation of demand rationales and governance roles, as outlined in [Figure 4](#) (and [Supplementary Table II](#)).<sup>5</sup>

The **‘principled gatekeeper’** speaker position incorporates the normative demand rationale which posits governance as a way to strengthen existing norms related to legitimate, transparent and inclusive decision-making to ensure/increase justice and equality. This underlying rationale is reflected in the types of governance roles associated with this speaker position, which include: ensuring accountability in the development of governance; pushing issues onto the governance agenda by bringing emerging topics to the attention of policy-makers; facilitating communication by increasing the level of public attention to emerging governance issues; and representing the rights and interests of those under-represented, such as minorities,



**Figure 4.** Speaker positions in the CE research governance debate and their associated demand rationales & roles. Green = positive governance roles, red = negative governance roles.

future generations and the non-human environment, in the development of governance frameworks. This speaker position was often assigned to/adopted by civil society organisations (predominantly environmental NGOs). An example of this type of speaker position assignment by an interviewee was: ‘I think NGOs have an important role in governance. Apart from anything else, just in keeping everyone else on their toes’ (Interviewee 08).

The ‘**responsible information provider**’ speaker position incorporates the functional rationale, which focuses on governance as rational problem solving, driven by utilitarian cost-benefit calculations and risk management concepts. Governance roles associated with this speaker position include are all suited to informing this type of functional governance development by: providing objective information to decision-makers to inform the development of problem-specific governance mechanisms; explaining or demonstrating the scientific grounds for the need for governance of a particular activity; providing ongoing input into the decision-making process to inform the iterative design of adaptive governance for emerging

technologies; and producing evidence of the effectiveness of specific governance mechanisms to deal with governance problems. Scientists were often associated with a responsible information provider speaker position, as one interviewee put it 'Science tells you the size and shape of the box you are trying to regulate' (Interviewee 05).

The '**strategic controller**' speaker position incorporates the strategic demand rationale, in which the call for governance is driven by the need to protect (national) interests, particularly relating to security and economic stability, motivated by a desire to influence (change or maintain) the balance of power. Governance roles associated with this speaker position include: developing leverage to constrain (undesirable) research activity and prevent conflict; providing robust authorization for desirable/useful research activities; engaging in long-term strategic societal and environmental planning to inform governance goals. This speaker position was assigned to/adopted by political decision-makers, as the following example illustrates: 'In our society, I think governments have to make the strategic decisions and have to put the resources behind whatever they want to get done' (Interviewee 14).

The '**self-benefit-maximizer**' speaker position is associated with an underlying logic of money- and/or power maximization. It is not associated with any of the identified governance demand rationales, and correspondingly, positive governance roles (roles that actively contribute to governance) were largely not associated with this speaker position. Rather, some negative governance roles (roles which need to be governed) were associated with this speaker position. These included: generating profit through research and technology development; close-holding information gained from research in an attempt to maintain competitiveness; and incentivizing and bank-rolling profitable (but not always useful) research. It must be pointed out that this speaker position, although being offered by the discursive structure, was not actively adopted by or assigned to any social actors in the data used for this analysis. Rather, it was being 'assigned' to nebulous 'others,' sometimes with implicit reference to unnamed industrial actors, as the following quote from one interviewee reflects: 'The government is basically put into a situation where they have to just trust that the industry is telling the truth because it can't give away all the information, because that would allow the proprietary data to given up and would allow, you know, competing companies to take advantage of that' (Interviewee 16).

My analysis identified some distinct patterns in the way in which different types of social actors are entering the CE governance debate. On the one hand, civil society representatives, scientists and policymakers are commonly associated with separate sets of positive governance roles and can enter the debate via the authoritative speaker positions of the 'principled

gatekeeper’, the ‘responsible information provider’ and the ‘strategic controller,’ respectively. Conversely, industrial actors are associated with negative governance roles and the only speaker position available to them is one which, by way of contrast, creates the need for the other three. Interestingly, the presence of this negative speaker position within the structure of governance debate is therefore necessary, as it makes the other three (positive) speaker positions possible and gives them purpose (Cf. Torfing 1999) (see Figure 4).

This analysis highlights that, generally, improving the understanding of the range of speaker positions available can help stakeholders engage in the governance debate more reflectively, and improved understanding of the constellation of speaker positions may facilitate communication between social actors adopting differing types of speaker positions. Furthermore, mapping speaker positions in the CE research governance debate helps to clarify how different types of social actors may engage with the Code. NGOs who adopt the ‘principled gatekeeper’ speaker position may tend to see the Code as a tool to ensure transparency, accountability and legitimacy. Policymakers who adopt the ‘strategic planner’ speaker position may be more likely see it as a way to facilitate coordinated and strategic research planning. Scientists who enter the debate via the ‘responsible information provider’ speaker position may perceive the Code as a way to support (or hinder) their ongoing production and provision of information to decision-makers.

## Conclusions: cracking the code

In drawing conclusions about this work, I am reminded of a cleverly cutting comment about my research made by a colleague: To her, discourse analysis seemed like producing detailed instructions on how to deconstruct and subsequently reconstruct an IKEA table; afterwards you might have a better understanding of how such tables are put together, but the function of the newly re-assembled table itself remains unchanged. The underlying criticism is clear – improving our understanding of the structure of a given debate may be interesting, but ‘so what’? At the risk of mixing metaphors, I prefer to think of discourse analysis as a type of reverse engineering – a way of cracking the discursive ‘source code’ with which a given debate is being continually written and re-written. An improved understanding of the workings of the constitutive ‘code’ underlying the CE governance debate, when paired with the discourse theoretical assumption that governance discourses constantly (re)form the objects and subjects of which they speak, can provide a novel way to address some of the key challenges of the anticipatory governance of emerging technologies. Rather than simply providing us with a static understanding of how the CE debate is

constituted, reverse engineering the dynamic discursive structure within which CE governance objects, subjects, roles and rationales are being (and may continue to be) formed can help us understand and critically discuss how governance may develop. My analysis has provided four initial insights in this vein.

First, diverging patterns of external differentiation and internal specification are currently underlying definitions of what should be governed by the Code of Conduct or other CE research governance mechanisms. The results suggest that if patterns of external differentiation based on the intent of CE activities become more central, CE research will be defined as a very broad, but nevertheless unitary object for governance purposes. This would correspondingly require the Code (and any other governance mechanisms) to be flexible and adaptable enough to be applied to the wide range of CE research activities that would be contained within such an internally heterogeneous governance object. Conversely, if the CE governance debate becomes predominantly structured by patterns of internal specification based on the scale and effect of CE activities, the result would be the formation of a plurality of governance objects. Governance, either in the form of the Code of Conduct or other mechanisms, may congruently be specified to apply to each of these narrowly defined governance objects.

Secondly, the heterogeneous understandings of what constitutes 'governance' in the field of CE research are all bounded by spatial (local to transnational) and functional (restrictive to enabling) dimensions. The relative positioning of governance definitions within this two-dimensional space suggests corresponding implications for governance development. Given the current heterogeneity of governance understandings in the field of CE research, emerging governance frameworks appropriate to these varying definitions will likely have to be both functionally flexible and adaptive to local, regional and international contexts.

Thirdly, this sphere of the debate as to why CE research requires governance is structured by three types of demand rationales: functional, strategic, and normative. Although all three types of demand rationales were present, a slightly wider range of reasons for the need CE research governance adhered to the normative rationale. According to Jinnah's demand-based theory of governance design, the emergence of a strongly polycentric governance structure may be most appropriate within the heterogeneous nature of the demand rationale constellation (Jinnah 2018, p. 8). Further, the fact that a slightly larger range of normative reasons for the need CE research governance were identified could suggest that polycentric governance structures focused on enhancing democratic legitimacy and inclusiveness in decision-making on CE research may be most imaginable within the governance demand structure identified here.

Fourthly, I showed that the discursive structure underlying CE research governance discussions offers four speaker positions: civil society actors tend to adopt and/or be assigned the ‘principled gatekeeper’ speaker position, scientists the ‘responsible information provider’ and policymakers the ‘strategic controller’ speaker positions. The negative speaker position available in the structure of the discourse the ‘self-benefit-maximizer’, is necessary, as its antagonistic exclusion makes the other three (positive) governance speaker positions possible. Identifying which speaker positions are being adopted can provide insights into how actors can be expected to engage with the proposed Code of Conduct (and other governance mechanisms). For example, actors who adopt the ‘principled gatekeeper’ speaker position may tend to see the Code as tool to ensure transparency, accountability and legitimacy, those who adopt the ‘strategic planner’ speaker position may be more likely see it as a way to facilitate coordinated and strategic research planning, and those who enter the debate via the ‘responsible information provider’ speaker position may perceive the Code in light of how it will affect their ongoing production and provision of information to decision-makers.

Overall, the mapping of the discursive structure has shown that there are clear interconnections between definitions of governance, types of demand rationales, speaker positions adopted, and understandings of how the Code (or other CE research governance mechanisms) could/should be implemented, at least within the policy sphere in the US, UK and Germany.

Structural mapping further offers an alternative lens for critically discussing the potential future development of CE research governance and provides a springboard for further research. Are similar (or different) discursive formations structuring wider spheres of the debate in different countries, and among a broader range of stakeholder groups? How do the governance terms, objects, roles and rationales underpinning *demands* for CE research governance correspond to other concrete governance proposals being put forward on the *supply* side of the equation? To what extent may elucidating power/knowledge structures underpinning the CE research governance debate enable those engaged in the debate to be more reflexive about the structures we/they are (re)producing? Could those who become cognizant of the potential shaping effects of discursive structures on the emergence of CE governance be emancipated to propose anticipatory governance that attempts to counteract such developments?

Additionally, such a mapping exercise provides a framework to investigate what types of terms, objects, rationales and roles are being systematically excluded by the bounding effects of these discursive structures: What is it *not* possible to say about CE research governance? What types of actors are being privileged or excluded within this discursive structure? What effects may this have on future governance developments? Notably, the speaker position



structure I mapped does not include a position through which publics could enter the debate and adopt specific governance roles (cf. Frumhoff and Stephens 2018). Furthermore, the results suggest that discursive structure may expand if additional knowledge types were incorporated in the CE governance debate, with potential corresponding effects on the development of future governance.

Climate engineering may well be the ‘quintessential anticipatory governance challenge’ in the sense that the future developments of the technologies and their governance remain ‘uncertain and contested’, but they are not entirely ‘unknowable’ (Gupta and Möller 2019, p. 481). Discourse is the source code with which contested futures are written. ‘Cracking the code’ underpinning the CE research governance debate can help anticipate and critically reflect upon the ongoing constitution of governance objects and subjects, rationales and roles.

## Notes

1. The terms climate engineering or geoengineering (hereafter CE) are used interchangeably and encompass proposals for both reflecting sunlight away from Earth (often called solar radiation management (SRM)), and permanently removing greenhouse gases such as carbon dioxide from the atmosphere (sometimes called carbon dioxide removal (CDR), Greenhouse Gas Removal (GGR) or negative emissions technologies (NETs)).
2. The Code can be accessed here: <https://www.ucalgary.ca/grgproject/files/grgproject/revise-code-of-conduct-for-geoengineering-research-2017-hubert.pdf>.
3. In focusing on the role of discursive structures, I am deliberately choosing to abstract from the agency of social actors in the development of governance. This is not to say that agency and politics do not play a role in the development of governance – I am simply bracketing these elements for the purpose of an analysis that focuses on the performative power of discursive structures in the dynamic co-constitution of governance.
4. The demand rationales identified in this study are not taken to be exhaustive but can form the basis for further comparative analysis to assess whether similar (or different) discursive formations are structuring the wider CE governance discourse.
5. Speaker positions are not mutually exclusive. They can be adopted by different types of social actors, and social actors can adopt a range of speaker positions.

## Disclosure statement

No potential conflict of interest was reported by the author.

## ORCID

Miranda Boettcher  <http://orcid.org/0000-0001-7975-4945>

## References

- Anshelm, J. and Hansson, A. 2014. Battling Promethean dreams and Trojan horses: revealing the critical discourses of geoengineering. *Energy Research & Social Science*, 2, 135–144. doi:10.1016/j.erss.2014.04.001
- Armeni, C. and Redgwell, C., 2015. International legal and regulatory issues of climate geoengineering governance: rethinking the approach. *Climate Geoengineering Working Paper Series: 021*. Oxford: Climate Geoengineering Governance (CGG).
- Asilomar Scientific Organizing Committee, 2010. *The asilomar conference recommendations on principles for research into climate engineering techniques*. Washington DC: Climate Institute.
- Bellamy, R. 2016. A Sociotechnical Framework for Governing Climate Engineering. *Science, Technology, & Human Values*, 41 (2), 135–162. doi:10.1177/0162243915591855
- Belter, C.W. and Seidel, D.J., 2013. A bibliometric analysis of climate engineering research. *Wiley Interdisciplinary Reviews: Climate Change*, 4 (5), 417–427.
- Biermann, F., and Möller, I., 2019. Rich man's solution? Climate engineering discourses and the marginalization of the Global South. *International Environmental Agreements: Politics, Law and Economics*, 19 (2), 151–167. doi: 10.1007/s10784-019-09431-0
- Boettcher, M., 2012. *Climate Engineering Discourse in the United States of America: Cautiously preparing for a Climate Emergency*. Master Thesis (Master of Arts). University of Heidelberg. doi:10.1094/PDIS-11-11-0999-PDN
- Cairns, R. 2016. Climates of suspicion: 'chemtrail' conspiracy narratives and the international politics of geoengineering. *Geographical Journal*, 182 (1), 70–84. doi:10.1111/geoj.12116
- Chhetri, N., et al., 2018. *Governing solar radiation management*. Washington, DC: Forum for Climate Engineering Assessment, American University.
- Corner, A. and Pidgeon, N. 2015. Like artificial trees? The effect of framing by natural analogy on public perceptions of geoengineering. *Climatic Change*, 130 (3), 425–438. doi:10.1007/s10584-014-1148-6
- Craik, N., Blackstock, J. and Hubert, A.-M. 2013. Regulating geoengineering research through domestic environmental protection frameworks: reflections on the recent canadian ocean fertilization case. *Carbon & Climate Law Review*, 7 (2), 117–124. doi:10.21552/CCLR/2013/2/253
- Diaz-Bone, R., 2006. Zur methodologisierung der foucaultschen Diskursanalyse. *Historical Social Research/Historische Sozialforschung*, 31 (2 (116)), 243–274.
- Foucault, M., 1969 (2002). *The archaeology of knowledge*. London & New York: Routledge.
- Frumhoff, P.C. and Stephens, J.C., 2018. Towards legitimacy of the solar geoengineering research enterprise. *Philosophical transactions of the royal society A: mathematical, Physical and Engineering Sciences*, 376, 20160459.
- Gupta, A. and Möller, I. 2019. De facto governance: how authoritative assessments construct climate engineering as an object of governance. *Environmental Politics*, 28(3):480–501. doi:10.1080/09644016.2018.1452373
- Hardy, C., Phillips, N., and Harley, B., 2004. Discourse analysis and content analysis: two solitudes? *Qualitative & Multi-method Research*, 2 (1), 19–22.

- Harnisch, S., Uther, S. and Boettcher, M. 2015. From 'go slow' to 'gung ho'? Climate engineering discourses in the UK, the US, and Germany. *Global Environmental Politics*, 15 (2), 57–78. doi:10.1162/GLEP\_a\_00298
- Hubert, A.-M., 2017. *Revised code of conduct for responsible geoengineering research*. Calgary: University of Calgary.
- Hubert, A.-M. and Reichwein, D., 2015. *An exploration of a code of conduct for responsible scientific research involving geoengineering*. Potsdam & Oxford Institute for Advanced Sustainability Studies Potsdam (IASS) & Institute for Science, Innovation and Society (InSIS).
- Huttunen, S. and Hildén, M. 2013. Framing the controversial: geoengineering in academic literature. *Science Communication*, 36 (1), 3–29. doi:10.1177/1075547013492435
- Huttunen, S., Skytén, E. and Hildén, M. 2014. Emerging policy perspectives on geoengineering: an international comparison. *The Anthropocene Review*, 2 (1), 14–32. doi:10.1177/2053019614557958
- Jinnah, S. 2018. Why govern climate engineering? A preliminary framework for demand-based governance. *International Studies Review*, 20 (2), 272–282. doi:10.1093/isr/viy022
- Jinnah, S., Nicholson, S. and Flegel, J. 2018. Toward legitimate governance of solar geoengineering research: a role for sub-state actors. *Ethics, Policy & Environment*, 21 (3), 362–381. doi:10.1080/21550085.2018.1562526
- Keller, R., 2011. *Diskursforschung: Eine Einführung für SozialwissenschaftlerInnen*. Wiesbaden: VS Verlag für Sozialwissenschaften.
- Keller, R., et al., eds., 2011. *Handbuch sozialwissenschaftliche diskursanalyse*. Wiesbaden: Verlag für Sozialwissenschaften.
- Keller, R., Hornridge, A.-K., and Schünemann, W.J., 2018. *The sociology of knowledge approach to discourse: investigating the politics of knowledge and meaning-making*. London & New York: Routledge.
- Kerchner, B. and Schneider, S., eds., 2006. *Foucault: diskursanalyse der politik, eine einföhrung*. Wiesbaden: VS Verlag für Sozialwissenschaften.
- Markusson, N., 2013. Tensions in framings of geoengineering: constitutive diversity and ambivalence. *Climate Geoengineering Governance Working Paper Series: 003*.
- Matzner, N. and Barben, D., 2018. Verantwortungsvoll das Klima manipulieren? Unsicherheit und verantwortung im diskurs um climate engineering. In: N. Janich and L. Rhein, eds.. *Unsicherheit als herausforderung für die wissenschaft*. Berlin, Oxford: Peter Lang, 143–178.
- Morrow, D., 2017. *International governance of climate engineering: a survey of reports on climate engineering, 2009–2015* doi:10.2139/ssrn.2982392
- NAS, 2018. National academies launching new study on sunlight-reflection research. In: *Developing a research agenda and research governance approaches for climate-intervention strategies*. Washington: The National Academies of Sciences, Engineering, Medicine. Available from: <http://www8.nationalacademies.org/onpinews/newsitem.aspx?RecordID=10162018>
- Nerlich, B. and Jaspal, R. 2012. Metaphors we die by? Geoengineering, metaphors, and the argument from catastrophe. *Metaphor and Symbol*, 27 (2), 131–147. doi:10.1080/10926488.2012.665795
- Oldham, P., et al. 2014. Mapping the landscape of climate engineering. *Philosophical transactions. Series A, Mathematical, physical, and engineering sciences*, 372 (2031), 20140065. doi:10.1098/rsta.2014.0065

- Porter, K. E. and Hulme, M. 2013. The emergence of the geoengineering debate in the UK print media: a frame analysis. *The Geographical Journal*, 179 (4), 342–355. doi:10.1111/geoj.12003
- Raimi, K. T., et al. 2019. Framing of geoengineering affects support for climate change mitigation. *Environmental Communication*, 13 (3), 300–319. doi:10.1080/17524032.2019.1575258
- Rayner, S., et al. 2013. The Oxford principles. *Climatic Change*, 121 (3), 499–512. doi:10.1007/s10584-012-0675-2
- Reynolds, J., 2019. Solar geoengineering to reduce climate change: a review of governance proposals. *Proceedings of the Royal Society A*, 475, 20190255.
- Schäfer, S., et al., 2015. The European Transdisciplinary Assessment of Climate Engineering (EuTRACE): removing greenhouse gases from the atmosphere and reflecting sunlight away from earth. *Funded by the European Union's Seventh Framework Programme under Grant Agreement 306993*.
- Scholte, S., Vasileiadou, E. and Petersen, A. C. 2013. Opening up the societal debate on climate engineering: how newspaper frames are changing. *Journal of Integrative Environmental Sciences*, 10 (1), 1–16. doi:10.1080/1943815X.2012.759593
- Shepherd, J., 2009. *Geoengineering the climate: science, governance and uncertainty*. London: The Royal Society.
- Sikka, T. 2012. A critical discourse analysis of geoengineering advocacy. *Critical Discourse Studies*, 9 (2), 163–175. doi:10.1080/17405904.2012.656377
- Stielike, L., 2017. *Entwicklung durch migration: Eine postkoloniale Dispositivanalyse am Beispiel Kamerun-Deutschland*. Bielefeld: Transcript Verlag.
- Stilgoe, J., Owen, R. and Macnaghten, P. 2013. Developing a framework for responsible innovation. *Research Policy*, 42 (9). doi:10.1016/j.respol.2013.05.008
- Surprise, K., 2019. Stratospheric imperialism: liberalism, (eco)modernization, and ideologies of solar geoengineering research. *Environment and Planning E: Nature and Space*, 2514848619844771.
- Torring, J., 1999. *New theories of discourse: laclau, mouffe and zizek*. Oxford: Blackwell.
- Uther, S., 2014. *Diskurse des climate engineering: argumente, akteure und koalitionen in deutschland und Großbritannien*. Wiesbaden: Springer VS.