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Pathway towards reaching the 1.5°C target and current proposed GE technologies

C2G2 Webinar on Geoengineering and Biological Diversity, November 2, 2017

I'm going to talk just a little bit more about geoengineering and, specifically, what role it might play in terms of an overall climate strategy.

[Slide] I think probably the single most important statement is that there is nothing in any of these technologies that changes the statement that "we must cut our carbon emissions aggressively," and the challenge is that right now basically there is no realistic pathway to achieving 1.5 °C.

I have written this slide qualitatively. That black line — we are not sure what our future decisions, how well we are going to be able to manage that — but 1.5 °C is probably out of reach; 2 °C is extremely hard; and if you add up the current Paris commitments, then that line would probably be more like 2.5 to 3 °C. And we can probably do better than that, but it is unclear how much better.

[Slide] The first set of things: the carbon dioxide removal. Bio-energy with carbon capture and sequestration has been in a lot of the integrated assessment models that try to aim for a 2 °C target or a 1.5 °C target without necessarily putting realistic limits on what is achievable with that.

Broadly, from a climate perspective, these things are all zero-risk. They will actually deal with the real problem of pulling the CO_2 out of the atmosphere.

The challenge with most of the CO_2 removal ideas is that they tend to either be hard to scale up and make a significant dent; or extremely expensive, as in most of the estimates for direct air capture; or they have some local issues. For example, terrestrial BECCS would have some issues with competition for land use.

The solar geoengineering is perhaps the little more thorny one. That affects the climate differently than CO_2 does, and so a 1.5 °C climate that you achieve through solar geoengineering does not look the same as a 1.5 °C climate that you achieve through emissions reductions alone.

The two main ideas that are on the table are:

• Putting aerosols up into the stratosphere. We know with certainty that that would reflect sunlight and cool the planet, from analogy with volcanic eruptions. But it also has other impacts, some of which are climatic impacts and some of which are less obvious what their impact would be, for example, changing the ratio of direct to diffuse light.

• Marine cloud brightening (MCB), basically as it sounds, puts salt aerosol into low marine clouds to reflect more light. In some ways, that sounds more benign, but it results in much more spatially heterogeneous forcing and some very large local forcing that might have some impacts.

So, in some sense, the question from a research perspective is whether following that blue pathway is less risky than following the green pathway or not. The answer to that question right now is uncertain, but my personal view is that there is enough risk of severe climate issues if we do not do solar geoengineering that it is essential to actually consider more research on it.

One final comment, just to reiterate. Doing solar geoengineering instead of cutting carbon emissions, there is essentially nobody who thinks that would be a smart idea. It is not even clear if you could keep the climate at 1.5 °C if you were trying to do that, but you would certainly then have to deploy solar geoengineering for thousands of years at very high forcing.

[Slide] Let me go to a specific scenario here. The previous slide was not quantitative. RCP 4.5 is one of the older IPCC emission scenarios but is roughly consistent with the current Paris commitments. I arbitrarily added a very large-scale CO2 removal in that at a scale that is on the high end of what many people think is plausible, but we simply do not know today what is plausible. With that amount of CO2 removal and that amount of overshoot, one of the immediate observations is that that overshoot is measured in centuries. So, if one were to deploy a sunlight reflection method of some sort, then one would be deploying it for several centuries.

[Slide] The top plot here is exactly the same. The bottom plot is just illustrating that none of these solar radiation management ideas will affect the climate system the same way.

The bottom plot is the global mean precipitation, and while you hold the temperatures constant at 1.5 °C in this scenario, the precipitation is actually pushed even closer back to preindustrial. If you could continue and look at all sorts of variables, you would find things — like ocean acidification, for example, is barely affected at all.

[Slide] This is a little bit more complicated, but just looking at maps of the planet. The left column is the temperature change. The right column is precipitation. The top row is that same scenario, end of century without geoengineering, and the middle row with geoengineering; and the bottom row is just pulling off a time period where one hits 1.5 °C without any geoengineering at all.

These are results from an average over 12 climate models. You should take it with a giant grain of salt because these climate models do not have a lot of the important physics in them. The only reason I put this up here, and the only takeaway, is that the limited climate modeling that has been done to date would say that it is plausible that a limited deployment of geoengineering — that is to say, say, going from 2.5 °C down to 1.5 °C — would be less risky than not doing it. The modeling that has been done to date says there is enough plausibility that it is worth continuing to do the research.

[Slide] I am going to skip most of this. This is just listing some of the methods, and Phil mentioned many of these as well. But just to reiterate, the CDR — the CO2 removal – we do not know how to do that today at scale, at a reasonable economic cost, and without significant local impacts.

The solar geoengineering does act quickly. We know in some sense that it would work, but we do not really know exactly what the climate impacts would be, and we do not know the sociopolitical as well.

So there are an awful lot of questions that we don't know about this. My personal view when people ask me is that this is probably 20 years' worth of research. Frank is going to talk a little bit later, for example, about how one would resolve a few of these uncertainties just as an illustration. But there is simply a lot of work to be done on this.

[Slide] Bottom-line conclusion is that at this point mitigation is necessary but not likely to be sufficient. Phil showed the chart from some of the scenario analysis that went into the IPCC reports. Even achieving a 2 °C target requires extremely aggressive cuts in carbon emissions and requires large-scale negative emissions right away that we do not actually know how to do. And to achieve 1.5 °C, within a rounding error, basically you have to stop emitting carbon today. That is simply not going to happen due to mitigation alone.

So the way to think about these technologies is really in terms of an overall strategic approach. We need to be able to develop the capability for CO2 removal and we need to do more research on the solar geoengineering to find out enough about it to be able to support informed decisions in the future.