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- [Email alerts](#)
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- [Parliamentary business](#)
- [MPs, Lords & offices](#)
- [About Parliament](#)
- [Get involved](#)
- [Visiting](#)
- [Education](#)
  
- [House of Commons](#)
- [House of Lords](#)
- [What's on](#)
- [Bills & legislation](#)
- [Committees](#)
- [Publications & records](#)
- [Parliament TV](#)
- [News](#)
- [Topics](#)

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## **The Regulation of Geoengineering - Science and Technology Committee [Contents](#)**

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### **Examination of Witnesses (Questions 1-33)**

DR JASON BLACKSTOCK, PROFESSOR DAVID KEITH AND JOHN VIRGOE

13 JANUARY 2010

**Chairman:** Could I say a very warm welcome to our guests around the world and, indeed, thank you very much indeed for joining us at what must seem an unearthly hour. It is snowing here in London and I am sure you will tell us what it is like around the world. We are very tight to timescale, and I am going to ask each of you to introduce yourselves very, very briefly so that we know that our feed is up and live, but first I am going to introduce our Committee to you. I am Phil Willis, the Chairman of the Science and Technology Committee here in the House of Commons, and on my immediate right is?

**Dr Iddon:** Dr Brian Iddon, Member of Parliament for Bolton South-East, Labour.

**Graham Stringer:** Graham Stringer, Member of Parliament for Manchester, Blakely.

**Mr Cawsey:** Ian Cawsey, Member of Parliament for Brigg and Goole.

**Mr Boswell:** Tim Boswell, Member of Parliament for Daventry.

**Q1 Chairman:** And on my immediate left is Glenn McKee, the clerk. That is our panel this morning. I wonder if I could ask John Virgoe if you could identify yourself, please?

**John Virgoe:** I am John Virgoe. I am on the line here from Canberra, where we have been enjoying 38degrees today.

**Q2 Chairman:** Professor Keith?

**Professor Keith:** David Keith, University of Calgary, where it is around zero.

**Q3 Chairman:** What time in the morning is it?

**Professor Keith:** One-thirty. No, it must be two-thirty; sorry.

**Q4 Chairman:** Thank you very much indeed. Dr Blackstock?

**Dr Blackstock:** Yes, is the audio working at this point in time?

**Q5 Chairman:** It certainly is; yes.

**Dr Blackstock:** Wonderful. I am Jason Blackstock from the International Institute for Applied Systems Analysis and the Centre for International Governance Innovation. I am in Boston right now and it is four-thirty in the morning and about 0<sup>+</sup> Celsius as well.

**Q6 Chairman:** John Virgoe, I wonder if I could start with you. It has been suggested that there is a need for geoengineering intervention. First of all, do you think that there is and do you agree that it needs global regulation?

**John Virgoe:** On the need, I think it would be premature to make that judgment at this point. The state of knowledge about geoengineering, both on the technical side but also on the political, ethical and regulatory sides, is simply not at a point where I think any sensible person would be able to recommend that we should be implementing a geoengineering technique at this point. I think, however, there is increasing reason to think that we may be heading that way in the future. I suppose it depends to some extent on your degree of optimism about whether the world will actually get on top of global warming through the mitigation methods and through international negotiations. If we believe that we may be heading in that direction and that in some years from now (and I would not like to put a figure on it) we may be looking seriously at a geoengineering intervention, I think it does make sense for us to be starting, at this point, not only to research the science and the technology, but also to think through some of these issues around the politics and the regulation so that when we do get to the point, if we get to that point, where we want to go ahead with these sorts of acts, we have thought about it and we are in a position to take a mature, measured and informed decision.

**Q7 Chairman:** Dr Blackstock, if we take John Virgoe's position as a sensible starting point, there is a huge number of international conventions with the potential to regulate geoengineering. Is there sufficient out there, or do we need to establish new positions? Dr Blackstock, can you hear me?

**Dr Blackstock:** Yes, I can.

**Q8 Chairman:** I was just saying that there is a huge number of international conventions with the potential to regulate geoengineering. Is that so, or do we need new ones?

**Dr Blackstock:** I think this depends in part on the types of geoengineering that you are talking about. Geoengineering is not a monolithic subject. The differences between carbon dioxide removal and solar radiation management and even, within carbon dioxide removal, the types that are engineered and, therefore, can be done on a global scale versus the ecosystem management, each of them requires different types of regulation, different regulatory structures. I think that for the engineering of carbon dioxide removal we do have methods in place that can fit largely within the local and national regulatory structures, but once you start getting into managing ecosystems or interventions into ecosystems at a larger scale across borders, we start to have more questions. CDR that is ecosystem-based, like ocean fertilisation, has already gone to the Convention on Biological Diversity and the London Convention and we have some regulatory mechanisms there. For solar radiation management I think we really lack the regulatory structure right now, and because solar radiation management—the sort of techniques of stratospheric aerosols, cloud whitening—are the only category of techniques that could be used with a rapid impact

on the climate system if we were to intervene, I think that we need to get these regulatory structures in place before large scale field tests are implemented. Because even when you start talking about field testing solar radiation management techniques, you start running into the potential for transboundary impacts, or at least a perception of transboundary impacts, and so international mistrust, international concern of what another country will do with that technology can come up very rapidly.

**Q9 Chairman:** Are you saying, Dr Blackstock, that the Convention on Biological Diversity would be a good starting point, or are you saying that that is sufficient?

**Dr Blackstock:** I am saying that for the different techniques we need different systems. There will not be (and I do not think we should think of there being) one framework which is sufficient to regulate geoengineering as a whole. If we differentiate the categories of geoengineering into the two broad categories of carbon dioxide removal and solar radiation management, I think those techniques that aim to remove carbon dioxide from the atmosphere, we largely have the appropriate regulatory mechanisms. There are some changes that could be made, but they largely exist. For solar radiation management, on the other hand, I believe we do not have the appropriate regulatory mechanisms in place, and I do not believe we have even a forum in which that discussion has begun to occur. I think we need more discussion at the international level of what type of regulatory mechanisms are needed, and that discussion should begin soon.

**Q10 Chairman:** Mr Virgoe, you disagree with that? You feel that we need a single regulatory body. I just wonder if you would let our Committee know how you think that that could work.

**John Virgoe:** In fact, I do not disagree with that; I agree with almost everything that Dr Blackstock said at that point. I certainly agree that when we are talking about CO<sub>2</sub> removal, the aspiration, at least, must be to make this part of a broader greenhouse gas management regulatory structure; that once we have addressed the issues around measurability, verification, the efficiency of some of these methods, then, ideally, we will be looking to see these methods implemented as part of a portfolio, if the price makes it sensible to do it that way. So that the countries faced with emissions reduction targets would have the option, and it would be a market-driven process, to what extent they wished to meet those. I agree with him entirely. We do not have the structures in place which would allow us to take the decisions and to regulate that process. The one area that I would differ slightly with him on that is I would certainly agree that we need to start the conversations around these issues as soon as possible, but that does not mean that we should necessarily be jumping straight into an international negotiation. The state of knowledge around these techniques and the possible unintended consequences is such that I just do not think we have enough knowledge to get into that sort of international negotiation and that actually getting into that international negotiation could lead us to some unwanted consequences, but I certainly think that we need to start the discussion and we need to start the discussion, in particular, around how we are going to manage the process of researching these things.

**Q11 Chairman:** Professor Keith, we have just had a rather disappointing Copenhagen summit with, arguably, science coalescing around a clear understanding that the planet is warming up and that we need to take very, very drastic action. We have still failed to be able to get the sorts of compensation agreements to support countries that require a great deal of support in order to put in carbon mitigation measures. How do you feel? Do you feel that there would need to be significant compensation for geoengineering which might be deployed by one nation but have quite a significant effect on another? Do you think it is possible to work that out?

**Professor Keith:** I cannot see the video. Can you hear me?

**Q12 Chairman:** We can hear you, so please carry on. We can see you now as well.

**Professor Keith:** Again, talking about geoengineering in general is almost meaningless, because there are completely different things in that project. I think the question really refers to solar radiation management, and that is governance is central at the point where we lock it, and the reason is that it is so cheap that the challenge for the international system will be to restrain unilateral action. It is precisely the opposite, or the converse, of the kind of challenge we face to reducing CO<sub>2</sub> emissions, but the challenge is to incentive as a collective act. I think we will need methods to do that and, indeed, those may be some of the most challenging developments, some of the most challenging the international community has ever faced. I do not think it makes sense to begin now to develop the full mechanisms for managing full-scale deployment, because I think we simply do not know enough. I agree with what John Virgoe has said. The crucial thing now is to think about how to start doing this from the bottom up through the management of a research programme in an international and transparent way. From the bottom up does not mean just that the scientists decide—that is certainly not the right answer—but it means, I think, that it would be premature to start a full UN scale EU Court treaty process, because it is simply not clear yet what the capacities are and states, individuals, have not had long enough to consider seriously what the trade-offs are.

**Q13 Chairman:** Very briefly, before I pass you on to Dr Iddon, it has certainly come to my attention that there is a real worry that the military use of geoengineering might become an attractive proposition for some countries. Is that something that worries you?

**Professor Keith:** Yes.

**John Virgoe:** I understand the concern. I am not a lawyer, but my understanding is that such action would actually be prohibited by the 1977 ENMOD Convention, which does outlaw the hostile or military use of environmental modification techniques. That does not mean, however, that the development of these sorts of techniques would not give rise to concerns, and that is certainly the case if militaries or, indeed, powerful governments were seen to be involved in developing some of these techniques. If we decide to move ahead with researching and possibly deploying these sorts of techniques, I think one of the big challenges for the world will be how do you actually deal with those sort of concerns? As I say, I think the legal position is that this would not be allowed under the Convention, but that does not mean there would not be concerns about it.

**Q14 Chairman:** Professor Keith.

**Professor Keith:** I would echo Mr Virgoe's comments on this. Let us try getting a scenario on the table. If a very small state, right now, decided to go out and deploy geoengineering with no prior consultation and with no adequate margin to go on, then, whether or not we had some prearranged international regime, it is pretty clear that the great powers would stop that small state. On the other hand, if a large state—and that does not necessarily mean a rich first-world country—began a serious ten-year programme of geoengineering research, subscale testing, and if that programme has international transparency in the form of an advisory committee that had some of the world's best scientists, and then that state moved, after, say, a decade, to say, "We are going to begin slowly and incrementally subscale deployment because we feel it will protect our world's interests", it would be extremely hard to stop. That state would effectively seize the initiative, especially if it was a nuclear power state. The reality here is that there are limits to what we can do in international law because, in the end, this gets to the core national interest. That is not to say we should not try, because, I think, in the end, the stability of the world is going to depend on this over time, but I would use this example to give you a sense of just how valuable it will be. Let us say China decided to do some modification that they think will improve their monsoon but make India's monsoon worse: that will not be directly, as John says, prohibited by an ENMOD treaty, but there is no question that will have a military response on all sides.

**Dr Blackstock:** I would build on Professor Keith's statement quickly and say that those two scenarios that he painted are the ends of the spectrum of possibilities, but as geoengineering research is developing, particularly on solar radiation management, somewhere in the middle ground seems more likely at this stage, where powerful nations begin research programmes on geoengineering and other states' perceptions of how transparent that is. For example, the EU, the UK and the US are all having these conversations about geoengineering; developing countries are not yet present. We need to consider the knock-on consequences of that middle ground perception that powerful countries are beginning to develop these technologies and may be pursuing not necessarily militaristic interests, but simply national climatic interests by developing these technologies. For example, on the next attempt at Copenhagen, the next attempt to get mitigation discussions going, there will be these arguments. I would agree with Mr Virgoe, we are not ready for international negotiations, but, I think, particularly by countries that are now starting serious geoengineering research, there needs to be an attempt to engage a broader dialogue with those countries which would otherwise feel marginalised on these subjects.

**Q15 Mr Boswell:** My specific question was about the regulation of these processes and what might be termed the international validation of them. It would seem to me (and this prompted my asking to intervene) that the UN Charter and the principle of self-defence, at one level, could actually be invoked by a nation state who wanted to do this by saying, "It is essential we do this in order to protect ourselves." Perhaps you would like to comment on that. Secondly, there is some analogy with the development of nuclear programmes, for example, in states which are not at the moment nuclear weapon states. There may be some suggestion that they are able to shelter under civilian regimes in order to develop what are essentially nuclear military programmes. Do you have any comments on those two?

**Professor Keith:** Let me pick up on the connection of nuclear weapons and point out that we do not just succeed on an international basis by formal treaties. Normal behaviour is very important, even if they are not formally within a treaty. So the norm that said no state should have that first use of nuclear weapons, no first use for them, had a profound role in the Cold War and yet it was not the core of any treaty. I think what we need to develop here are both norms and treaties and we should not look at necessarily getting through a written treaty.

**Chairman:** I am going to leave that there and bring in Dr Brian Iddon.

**Q16 Dr Iddon:** Good morning, gentlemen. Are we quite clear about the width of geoengineering? What I mean by that is that weather-changing techniques such as cloud seeding might be considered to be geoengineering. Do you encompass those techniques within your definition? Could we start with John Virgoe perhaps?

**John Virgoe:** I certainly would not encompass that. One of the criteria for me for geoengineering is that the effect needs to be at a global level, and cloud seeding is a weather modification technique. We should not get hung up, though, on the precise definition of geoengineering for a couple of reasons. One is that the term is a very scary term and I think it does inhibit sensible debate around these techniques. The second is that the term has come to encompass at least two quite different things which are both technically different. I am talking about techniques for

solar radiation management on the one hand and for taking CO<sub>2</sub> or other greenhouse gases out of the atmosphere on the other. They are quite different technically but also in terms of their non-technological implications. Currently I find it more helpful to think in terms of unconventional or complementary techniques and then to look at them one by one. I think the category of geoengineering is possibly starting to no longer be a particularly helpful one.

**Q17 Dr Iddon:** Professor Keith, do you agree or disagree with John Virgoe?

**Professor Keith:** I strongly agree. I think all three of us have said that in different ways. Let us try and help this by being specific. If biochar is geoengineering, it certainly does not bring out the kinds of direct international security concerns that are brought out by the capacity to do stratosphere solar radiation management, and the reason is all about leverage and money. The fact is that with the right technology it may be cheap enough, through engineering the stratosphere, that literally individual human beings may have the wealth necessary to introduce an ice age. I say that to be deliberately provocative, but there is evidence that is in fact correct, and that enormous leverage—the concept being so cheap—means that the threat of unilateral action is real and the impacts could be very substantial. There is no comparable issue with, say, biochar, and for that reason the sort of regulation management we need is completely different.

**Q18 Dr Iddon:** Dr Blackstock, do you have any comment?

**Dr Blackstock:** I would echo the comments that were just made and build on them, just saying that it is the transboundary impacts, the impacts that go beyond the boundary of one country, that are really going to drive the international regulatory frameworks that we need to develop, and so for a working definition of geoengineering there is obviously the question of intentional intervention requirements. As David Keith just raised, biochar does have the intent of keeping the global atmospheric concentrations of CO<sub>2</sub> down, but the near-term transboundary impacts are minimal. When we think of developing regulatory structures for what we class as geoengineering, our primary concern should be about how large is the transboundary impact and how soon will that transboundary impact manifest? This is what focuses a lot of the conversation that you heard on solar radiation management, the fact that that can impact the climate system in the near-term, whereas the CDR techniques, the carbon dioxide removal techniques, have a much longer time lag behind them. Just to echo the last question that was asked about nuclear technology and build-up—Professor Keith's point—as David mentioned a couple of times now, solar radiation management technologies appear relatively cheap, which also means relatively technically simplistic. Therefore, the analogy to nuclear technologies becomes much more challenging, because most of the technologies required to actually deploy solar radiation management are things that are available to numerous countries already. These are not technologies that require huge technological progress from where existing technologies are at. The idea that we can potentially regulate and control the technology underlying solar radiation management, like we do, or attempt to do, with nuclear technologies, is not a good analogy for this. The technology is going to proliferate and be accessible to a large number of individuals or countries and, therefore, we have to look at controlling behaviours in this case, not just access to technology.

**Q19 Dr Iddon:** My second question is about risk. Should we be categorising geoengineering techniques as low risk, medium risk and high risk? If you agree with that, should there be separate regulatory regimes for each risk area? Could I start with Dr Blackstock, please.

**Dr Blackstock:** Simply having three categories of low, medium and high risk, as all three of us have already echoed, there are slightly different things that you would want to lump into categories, that you would want to define the technologies according to, and I think what you have heard echoed here already is an attempt to classify these things in precisely that way. The high risk technologies in this case that we have been discussing, high risk geoengineering methods, are those of solar radiation management because of the cheap and easy technology for implementation, the near-term impact it can have and, therefore, the potential for unilateral action. That creates a high risk category that does require a different type of regulatory framework than, for example, is necessary for biochar or the other carbon dioxide removal techniques, that is a useful framework of low key and higher risk, but understanding why those classifications of higher risk versus lower risk are made will be a very important part of any regulatory framework. That echoes Mr Virgoe's comment that we need a lot more research to understand the science underlying these techniques before going for full-scale negotiations and real international regulation.

**Q20 Dr Iddon:** Professor Keith, do you agree?

**Professor Keith:** Yes, generally I agree with what Dr Blackstock has said. I think that categorising things like the amount of leverage might be more useful than boundaries. There are things like that, low leverage, where it is implausible for a small amount of money or a small stated effective load and may have high or low risk, and those things do not need a kind of international governance that they will eventually need for these high leverage technologies like solar radiation management. I think actually that high, low, medium risk categorisation is not a particularly useful way to think about overall governance. We need to think about the specific, very different timescale and leverage differences.

**Q21 Dr Iddon:** John Virgoe, finally?

**John Virgoe:** I would agree with both of those comments and just observe that I think we are talking about a number of different sorts of risk here, and it is going to be important to pick these apart. There are environmental risks, risks of things going wrong or risks of unintended side effects. There are also political risks, and we have touched on some of these already, and I think there are a number of other potential political risks, risks to the international system, to multilateral or bilateral relations. It is something that particularly concerns me. There is clearly a risk that the techniques do not work and there are also risks around things like legal issues and liability. I think there is a whole range of different risks, and we probably need quite a sophisticated framework for assessing those, but ultimately, you are right, we will be in the business of balancing risks and balancing them against the risk of runaway climate change essentially.

**Dr Iddon:** Thank you, gentlemen.

**Q22 Mr Boswell:** I will start with Mr Virgoe, if I may. In your paper, which is very helpful, you suggested developing guidelines that would apply to the whole area of research into geoengineering. My first question is: who should be formulating these? Should this be individual governments, international organisations or, possibly, some kind of consortia of academics or NGOs that does it?

**John Virgoe:** I think that is an extremely interesting question. I do think that the development of, I suppose, what might more appropriately be called norms or principles is the first task and is a particularly urgent task given the urgent need to restrain what we might call irresponsible entrepreneurial activity in this field. We need to develop these norms and we need to socialise them among the community of nations, the community of scientists and other stakeholders. How do we do that? As I suggested earlier, I do not see turning, in the early instance, to the international multilateral process, negotiating it a treaty, as the right way to go in this. I think the state of international understanding and also the knowledge base is currently so weak that you could get outcomes that would not be the right one. I think it is very possible to imagine, if this is put on the table in some sort of UN forum, you could end up with a decision, basically, to make geoengineering a taboo, to outlaw it, and that would be a mistake, for a couple of reasons. One is that it may be that we actually need to be doing this research and that, some decades down the line, we will be very sorry if we have not started thinking through these techniques. The second is that I think there are a lot of actors out there, as we have all already said several times, with the capacity to research and implement these techniques. Some of them may not feel bound by that sort of international decision, some of them may not be as responsible, and it would be very unfortunate if what geoengineering research was happening was going on under the radar screen, if you like. What we need is an open process which builds on some of the principles that are already out there around similar issues; for example, principles developed to deal with long-range air pollution or weather modification: principles around openness, transparency and research, notifying a neighbouring country or countries which might be affected. We probably develop these through maybe a slightly messier process than an international negotiation. Individual countries will have a role; communities of scientists will certainly have a role. I think if you look at some analogues, for example, around genetic engineering, fusion physics or, indeed, carbon capture and storage, to come a bit closer to home, you can see examples where research norms and principles have been developed almost from the bottom up in that way involving groups of scientists, other stakeholders and interested countries.

**Q23 Mr Boswell:** That is very helpful. Would the other two, Professor Keith or Dr Blackstock, like to comment?

**Professor Keith:** Yes. I think there is a role for bottom-up generation of norms that has to start most of all with just transparency alone. I think there are parts of the international scientific community, such as the national academies and bodies that link the national academies, such as the InterAcademy Council, that can play an important role here. That is not to say that this should just be the domain of scientists, because it should not. It is vital that we find a way to get a larger set of witnesses in here, not have a reality or perception that the scientific community alone are deciding what to do purely based on research. One of the wonderful things about the global scientific community has been its ability to operate internationally and have some level of transparency even in the middle of the Cold War, and I think that building on that is a certain key way to start but it needs to be done in many places, and we need to have different efforts to develop these norms of behaviour going on, whilst I think it would be a mistake to go for a single, unified system too early.

**Dr Blackstock:** Could I just add one thing on top of what my colleagues have said, which is that when speaking about research on low scales where the research itself has no transboundary impact—for example developing the deployment technologies, laboratory research, computational modelling—for that the framework of developing norms within the scientific community as a bottom-up process, I think, is very political and will work well. I am more sceptical, however, when we start talking about field tests, particularly what Professor Keith has been referring to as high leverage geoengineering technologies, which are specifically the solar radiation management type. When we start talking about field tests, it is a question of—

**Q24 Mr Boswell:** I interrupt you. Typically crossing national boundaries at that level. The field test would be typical.

**Dr Blackstock:** Yes, at some scale you can do what you refer to as subscale field tests, which are tests of such a small scale that they do not have transboundary impact, but defining where that boundary is between subscale and actually having transboundary impact—and this goes a little bit to what Mr Virgoe has just said—there are two types of risk. There is the actual technical risk, the environmental risk, but then there is the political risk in just the

perception. One can conduct what is nominally a subscale test, but the political perceptions of your neighbours can be different to that, and so when talking about the types of research that begin to get into actual environmental testing of these technologies, I think we have to be more cautious about what we are seeing, based on norms alone, prior to a political agreement. We saw an example of this in this last year with the ocean fertilisation experiment, the Lohafex example, that was the Indo-German collaboration that ran it, and the political controversy that emerged surrounding that. Nominally that test would have had very subscale impacts in terms of the ecosystems and certainly in terms of transboundary, yet the political controversy agreed because of the perceptions and the fact that the Convention on Biological Diversity and the London Convention had already been discussing these issues. When you start doing field tests, you start raising more political issues. I think the consideration of the norms is partly necessary but not sufficient to address the sort of political issues that will raise.

**Q25 Mr Boswell:** The second question is really for all of you. By prefacing it, I think I would say that it sounds to me as if the words "norms", "guidelines" and "principles" are pretty well interchangeable, and you might like to comment on that, but a group of leading academics have suggested five key principles—that is the word they use—for guiding research. Broadly, first of all, that geoengineering be regulated as a public good; secondly, the importance of public participation in decision-making; thirdly, disclosure of geoengineering research and open publication of results; fourthly, the independent assessment of impacts; and, fifthly, governance before deployment. I think that last one implies that you start the guidelines and you work on the governance at the stage where you need to perhaps develop specific research projects. They sound pretty good to me at first sight, but are they practicable as a basis for at least starting to consider the acceptability of research? Would Dr Virgoe like to start on that, or whoever?

**John Virgoe:** I am happy to go first, but I should say I am not a doctor.

**Q26 Mr Boswell:** I am sorry.

**John Virgoe:** On the five key principles, I also agree that they sound pretty good at first sight, or at least three of them do. I would absolutely agree with the principle of open publication and disclosure of research. I think this is absolutely key. The surest way to excite international suspicion about what you are doing is not to be open about it, and that applies whether you are a community of scientists or whether you are government, of course. Starting with governance first, independent assessment of impacts sounds like a good idea to me as well. The two that I have some question marks over are the first two, however. Implementation in the public good. Yes, it is motherhood and apple pie, but I think when you delve below that you have to ask: who is the public in this case? The global public. We are talking about interventions which will affect the planet as a whole, and there are number of publics out there. There are some publics out there who are suffering very badly, or will be suffering very badly, from the effects of climate change. There are some populations out there who may have seen some benefit from climate change and, therefore, not be very happy to see climate change being put into reverse gear, if we were ever able to achieve that. The impact of some of these techniques is likely to be heavily differentiated. It is not necessarily the case that we will simply be able to slow climate change or put it into reverse at the same rate across the world. You may find some areas were continuing to warm, other areas cooling faster and, of course, unintentional side effects. I think once you peer below the surface of the public good, it becomes quite hard to define it and you get into some difficult ethical territory. As far as public participation is concerned, again it sounds good, but I find it hard to imagine quite what that means at the global level. How do you actually bring about public participation at the global level and how do you ensure that certain parts of the public, or the public in certain countries, do not have privileged access compared with other countries, publics or other parts of the global public?

**Q27 Chairman:** Could I ask you to be as brief as you can, because I am desperately trying to get in another set of questions before we run out of our link. Can I ask you to be very brief in your answers, please. Dr Keith?

**Professor Keith:** I want to return to a previous conversation, because I think it got on to the key point where there is a little disagreement probably between us. Dr Blackstock was suggesting that we need to have political agreement before we do any subscale testing. I would submit that that is problematic. For one thing, the Russians are already doing subscale testing. For another thing, it has recently become clear that, despite all the talk about stratospheric geoengineering, the main method people talk about basically does not work. That is, if you put sulphur in the stratosphere the way we have been assuming, it does not do what we thought. You could do tests on this. These would have no detectable climate effect, but they would be subscale tests, and if we want to actually understand whether this technology works or it does not, we need to do those tests relatively soon. If we say we are not going to allow them until we have a political agreement, essentially that gives a veto to any power that does not want to see that. I think we have to really think hard about whether that would be an appropriate strategy or whether the default outcome of that would be that there was no serious progress in our standard of understanding.

**Dr Blackstock:** I would quickly respond to Professor Keith's point and say I agree with most of what he has just said. The issue that I am trying to raise is the question of how the politics play out. As he pointed out, Russia has begun doing subscale field tests, and they are extremely subscale, at a point where there will clearly be no transboundary impact. While I would agree that we want to progress our science—and we will need to do some of this subscale testing to understand the feasibility of some of these technologies—we want some international mechanism, some mechanism of legitimacy, for defining what subscale actually means to begin with, and then, before we start pushing the boundaries of what questionability of subscale, that is, I believe, where we really need to have, not just scientific, but political agreement. As Professor Keith raised before, the international grouping of national academies could be the right body for being able to make a declared statement of a subscale test being

actually subscale, but there will be cases where the politics will overrun that and individual scientists, and particularly nation states supportive of subscale testing, need to be very aware of the political issues it can raise and be proactive. In responding directly to this last question, norms, guidelines and principles are all, I feel, interchangeable words, but what I think needs to be considered are commitments. There are some debaters that have operationalised these principles, but I think that nation states who are now starting to fund research, particularly if it goes to funding subscale experimentation, we need to ask what preventive commitments, what precautionary commitments nation states need to make about the sort of research and transparency that they are going to want to commit to up front in order to avoid exacerbating all the mistrust that already exists within the international climate arena.

**Q28 Mr Cawsey:** Mr Virgoe, in your written submission to us, you make the point that it would be necessary to be cautious in the way international debate on geoengineering is initiated. Indeed, you went further to say it may well be banned in line with the precautionary principle if we do not. Why do you think this might happen? Should we prevent it and, indeed, can we?

**John Virgoe:** I think we can try to prevent it by being careful in the way that we raise the issue. To take a very crude example, if you were to take a proposal around geoengineering straight to the floor of the United Nations, in whatever format you liked, you have to think about the politics of how countries would respond to that. At the moment the state of knowledge around geoengineering, the state of understanding, is not great. I think a number of countries will be very alarmed by that proposal. A number of countries might see it as an attempt by the developed nations to escape from having to make cuts in their greenhouse gas emissions; others might be very excited to hear about this potential solution to climate change. I think the consequences of that sort of unprepared debate in that sort of format would be very unpredictable, but you might get a decision of one extreme or the other, either to ban geoengineering or to rush ahead with it when we are really not at the point where we can say that this is at all a sensible road to be going down. That is why I am arguing for a much more cautious and bottom-up approach to putting this on the international agenda.

**Q29 Mr Cawsey:** The UK's Natural Environment Research Council has launched a public consultation on geoengineering and it has asked for comments on two topics: what are your thoughts on the hopes and concerns about the potential use of geoengineering technology and what questions people should be asked about the future of geoengineering research? Is that going too far too quickly, or is that sensible? Do you support that consultation and what issues and options should be considered? I will start with Mr Virgoe, but I would be interested in what other witnesses have to say as well.

**John Virgoe:** I thought that was a very interesting initiative and seems to me to be a sensible way of starting to start debate.

**Q30 Mr Cawsey:** Professor Keith?

**Professor Keith:** For other consultations to really work, it requires more than just having an open door for the public to pour comments. I think that is a necessity but it is really not sufficient. Good public consultation requires help to give members of the public the tools to ask scientists what is going on and understanding the technical facts, and it typically is more effective if a small group of representatives of the public get to debate and work issues out for themselves and then report. There are various methods of this kind of symmetrical democracy that can work, and I think that pure kind of classic consultation patterns may not be all that helpful.

**Dr Blackstock:** I agree. I would echo that statement from Professor Keith that a more active educational role or involvement in education about these ideas is essential. I would just build back up to something that Mr Virgoe raised in his framing of how we could go wrong by rushing forward in the international community. This programme of starting communications within the UK is a good start, but because of the truly international scope of these geoengineering technologies that we are talking about, we have to ask ourselves who are going to be some of the most sensitive communities within the international sphere who we definitely need to take a proactive role engaging in the conversation early. I can think particularly about countries who already have populations marginalised in terms of climate change or are on the edge of suffering from climate change impacts, because those marginalised populations are likely to be the ones most sensitive to geoengineering experiments and a high level of solar radiation management experiments and particularly implementation. There is that risk that without directive public engagement, an attempt to reach out and provide the information proactively and indeed in a conversation, that we end up with them inevitably being surprised later on by rapid climate change impacts for these technologies which can lead to the unilateral and rash actions that we have been trying to steer that by doing informed research and responsible research we can hopefully avoid, but that requires international public consultation, not just domestic.

**Q31 Mr Cawsey:** I was going to go on about the Engineering and Physical Sciences Research Council undertaking workshops and sandpit events and ask if you thought other countries should do the same or whether it should be internationally focused, but you are clearly saying you think this should be an international endeavour, not just done by individual states?

**Dr Blackstock:** That would be my opinion on this, yes.



**Q32 Mr Cawsey:** Mr Virgoe?

**John Virgoe:** Certainly I agree with all of that. I think you have to look at the political structures in some of the countries that I think we are referring to and ask yourself whether going straight to public consultation nationally would actually make sense, but the broad principle that we have to avoid anybody, any country, certainly any powerful country, feeling either threatened, or suspicious, or surprised by any action or discussions we may be having in this area: I absolutely agree with that principle.

**Q33 Chairman:** I will have to call this session to a halt. I am sorry, Dr Keith, not to bring you in there. Could I thank you all very much indeed for joining us on what is the beginning of a journey. It is a piece of work we are doing jointly with the US Congress Science and Technology Committee, but we thank you very much indeed, Dr Blackstock, Professor Keith and John Virgoe, for your help in answering our questions this morning. We wish you either a good night or a good morning. Thank you very much indeed.

**John Virgoe:** Thank you.

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[Previous](#)

[Contents](#)

[Next](#)

[Commons](#)

[Parliament](#)

[Lords](#)

[Search](#)

[Enquiries](#)

[Index](#)

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