REWIND: Remaking the Planet

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Greg Dalton: Hackers break into just about every big system these days, from global ATMs to the Pentagon and national retailers. Today on Climate One we'll talk about hacking into the biggest operating system of all, the Earth's climate system that runs our weather and supports the economy. For decades, a small group of researchers in the United States and other countries have been tinkering with the idea of hacking the sky by spewing dust into the air. They say humans could simulate volcanic eruptions which are known to temporarily cool the earth as temperatures around the world continue to rise. The idea of such geo-engineering has move from science fiction to serious consideration. Over the next hour we will talk about the scientific, moral, economic and technological dimensions of humans getting so hot they decide to break the glass and spray a huge fire extinguisher in the sky.

Joining our live audience at the Commonwealth Club in San Francisco, we're pleased to have with us three guests deeply involved in the geo-engineering debate. Ken Caldeira is a Climate Scientist at the Carnegie Institution for Science at Stanford University, and a foremost expert on geo-engineering. Oliver Morton is Briefings Editor at The Economist and author of the new book The Planet Remade: How Geoengineering Could Change the World. Kim Stanley Robinson is an award-winning author of science fiction. His most recent book is Green Earth, a compilation of his Science in the Capitol trilogy. It depicts a fictional US President Phil Chase living in Washington DC at a time when the Gulf Stream is disrupted and some winters hit like an Ice Age. It sounds familiar.

Kim Stanley Robinson: I get a lot of emails about that.

Greg Dalton: Please welcome them to Climate One.

[Applause]

Oliver Morton, let's begin with a story: 1965, US President Lyndon Johnson receives what is one of the first time a US president receives a report on climate change. And rather than talking about reducing the source, Roger Revelle had a novel idea for addressing it. Tell us that story.

Oliver Morton: Well, yeah, this is – the reason that the story matter so much is because it shows you how attitudes to the climate in the right place for humans to be in the world can change quite strongly in quite short periods of time. So Revelle has done the work in the 1950s that has shown that carbon dioxide is, contrary to some previous expectations, building up in the atmosphere. And he knows that this is going to lead to a level of greenhouse warming and he puts this into the report

to the president in 1965, it’s a sort of - it’s an appendix to this report and says what should we do about it. And in 1965, talking to Lyndon Baines Johnson, you do not say well we're going to radically change the whole nature of capitalism, you don’t say we’re going to do anything about people making oil in Texas. You say things like we could put lots of little reflective bubbles on the surface of the ocean and reflect back some of the sunlight.

And at that time, the idea of a technological fix had not taken on the somewhat condescended to sense that it has today. The idea for technological fix did not seem in and of itself absurd. And it’s quite extraordinary that just in 50 years the fact that that was the only thing that report said, now seems extraordinary to us. But maybe in 50 years after now people will say the degree to which people are unwilling the president able to talk about this form of geoengineering, not little balls on the ocean, but any form of geoengineering maybe that would also look strange.

Greg Dalton: There’s another story a few years later, Edward Teller and some other scientists were exploring the impacts; obviously this is the height of the Cold War nuclear winter and how is that connected to the evolution of what is geo-engineering?

Oliver Morton: Well it’s connected in an interestingly unexpected way. When people talk about nuclear power throughout the early part of the 20th century, they link it in their minds with power over climate. Because it seems like it’s like ultimate godlike power and so the great British radiochemist [Frederick] Soddy, when he writes the first popular treatment of radioactivity in the early 20th century, talks about how it can destroy icecaps and make deserts bloom that’s what nuclear energy does. Same thing happen straight off to the second world war, Julian Huxley, Aldous Huxley’s brother, talks about maybe melting the Arctic ice and making a new world for us all up in the Arctic and this is the power of the atom. But when people like Teller actually talk about using atomic weapons, atomic power to actually fight wars, oddly this story goes in reverse. And for many, many years people do not talk about the climate impacts of nuclear war. And now it seems again in retrospect blatantly obvious that if you set off huge fires over much of the surface of the earth, you might do something to the climate. But there is sort of like studied – and I don't think deliberate, but definitely psychologically telling – refusal to engage with that. And so the idea of nuclear winter comes about much later than most people think. I mean, I’ve chosen to correct some fairly eminent historians on this that they all talk, “oh nuclear winter, that idea of the 60s and 70s.” No, it starts in the 1980s. It was an idea, it was a way of thinking about the world, a way of thinking about human power within the world that was very late to come to attention because there was a vested interest in thinking that in some ways nuclear world could, nuclear power could end the world without changing it.

Greg Dalton: Or that nuclear power war could be fought and winnable, that sort of thing. Ken Caldeira, let’s have you explain what is geoengineering give us a brief explanation of – this is a very abstract concept; how do you describe it?

Ken Caldeira: There are two main categories of geoengineering. If we think about the global warming that humans are producing. It's primarily due to the fossil fuel CO2 that we’re adding to the atmosphere and this carbon dioxide in the atmosphere makes it more difficult for heat to escape to space.

And so one approach which is relatively noncontroversial is to just remove some of the carbon dioxide that we’re adding to the atmosphere. But if we think about what’s heating the earth up to begin with, it's the sunlight hitting the earth and we're absorbing this solar radiation. And so another way to cool off the earth would be to reflect some of that incoming sunlight back to space. And this is precisely what volcanoes do and the earth is cooled after each of the large volcanoes that have occurred over the last 50 years or so. And so the other leading idea is basically to emulate what

big volcanoes do, put material in the stratosphere to reflect sunlight. And there's a few other ideas as well, but they're all based on the same idea of reflecting sunlight back to space.

Greg Dalton: Kim Stanley Robinson, is that is comprehensive enough, the idea of either sucking carbon out of the sky or bouncing heat back toward the sun?

Kim Stanley Robinson: Well, I think that the common understanding of this term geoengineering has morphed fairly quickly to the notion that it would be a technological silver bullet. Where you could do one thing and solve the problem of us burning fossil fuels. So people immediately object to it as a kind of a moral hazard that if we think that we can get away with it that we won't decarbonize fast enough. And then also there's a certain resistance to the technocratic in general, of taking over of the not just world history, but even planetary ecosystems themselves by some poorly defined technological elite with a method in mind and so many things have gone wrong in the human interventions in this planet before that people distrust in on several levels. So it's getting attacked almost immediately for things that are not quite right or true. And yet there's reasons why these attacks have come about. For instance, people will say well, you put something up in the atmosphere and then we're gonna accidentally cause an ice age and there's not an understanding that like volcanic explosions that dust goes in the atmosphere, for five years it's cooler then it falls down to the ground.

So in a way, this is kind of an experiment that we could run that has a natural terminus to it. So it's a little bit safer than other things that might be suggested. So yeah, it's gotten complicated. I always try to say well geoengineering if we change if we plant a lot of forests, if we give all the women on the planet their full legal rights, we've changed the climate of the earth in a radical way so that's geoengineering too. And this kind of blows the discussion apart and I'm not sure that's where we want to go tonight. But I think it's important to point out that we're talking about humanity's relationship to the biosphere and the planet as a complex system that we can't hack, that's not the right word, but we might be able to finesse it in ways that will keep us from causing a mass extinction event. So we need to talk about it, but it can quickly get scary in several different ways.

Oliver Morton: Yeah, I don't particularly like the "hack" metaphor. But I – one thing that you were saying I can't emphasize enough. The idea that there is in some minds and I think in some the popular conception of geoengineering that it's necessarily an alternative to reducing fossil fuel emissions is pernicious and wrong. There's no iron law that says you have to have one or the other. You can quite easily imagine worlds where you have both and. And then there is this idea of moral hazard, this idea that if you have geoengineering, moral hazard being the idea that, if you insured against risk or in some other ways, other way immune to risk, you will be riskier. And it's clear that that moral hazard is a real thing in the world. You can look at the banking system and see an awful lot of moral hazard and the people will take risks if they think they'll get bailed out.

But that doesn't apply only to geoengineering and it doesn't apply only to solar geoengineering. The biggest amount of moral hazard that I see in the geoengineering debate at the moment is actually with the carbon dioxide stuff. I was at the Paris Climate Conference and it was a very inspiring conference to be at. And it came away with the world actually having the system for talking about dealing with this problem, and with a set of ambitions of keeping warming well below 2 degrees which is, you know, a high level of ambition but with pledges on action that are grossly insufficient to that high level of ambition. And so what you're finding in the discussion about future emissions at the moment is an acceptance that in the second half of the 21st century and the first half of the 22nd century something, somewhere we'll be pulling carbon dioxide out of the atmosphere. Well, there's no real discussion about how that's going to be done. And that's where moral hazard gets really dangerous because you begin to say, well, always we can trade off emissions cuts now with more sucking out later, when you haven't really done the research in a way to find out how you might do

that sucking out, whether what level of sucking out as possible. That’s very tricky.

So there’s been a lot talk about moral hazard with the sunlight mechanisms. I think sunlight mechanisms from this point of view, not from all points of view are kind of safer because it would be a really big thing that you know there would be big political debate about to do that. At the moment, now that we've let emissions, now we've let negative emissions, carbon dioxide reduction into our thinking, but haven't stopped to work out how to actually do it I think that's the area where there’s moral hazard at the moment.

Greg Dalton: Ken Caldeira.

Ken Caldeira: Yeah, just to build on some of what Oliver was just saying. In Paris at this COP 21 meeting, the governments of the world. If you look at what emissions they've promised to try to hold themselves to over the next decades to and then they claim this 2 degree or 1.5 degree targets, in order to meet those targets, the governments basically need to remove large amounts of carbon dioxide from the atmosphere later in the century. So essentially geoengineering in the way of removing carbon dioxide from the atmosphere is the implicit policy of every major government in this world right now.

Greg Dalton: Well, some would say that stop burning fossil fuels would be a big part of that. That a lot of the technology already exists today. Renewables are there, that somehow geoengineering is a way to let the fossil fuel companies keep doing business as usual and us to keep living like we do.

Ken Caldeira: I think there's a fundamental – again this area is presented often as a dichotomy, either we reduce emissions or we do these geoengineering –

Greg Dalton: Okay, we heard it’s gonna be both.

Ken Caldeira: And I think that maps onto this feeling like we can either change ourselves and our behavior and our social and political environment or we can go for some techno fix. And I think there’s just a feeling that we need to change our political and social environment and that we can't just rely on technology. And this is really where Edward Teller comes in because he never trusted social systems to solve problems, and thought, oh we need to invent technology to solve our problems, which is one of the reasons why we’re here at this moment.

Greg Dalton: So Ken Caldeira, where is the status of testing today? Is there any testing going on today either openly or secretly at the US, at the Pentagon or anywhere else?

Ken Caldeira: For carbon dioxide removal there is testing. There is a pilot plant going on up in Canada right now and also of course planting forests and so on, is a form of carbon dioxide removal. For the sunlight reflecting techniques basically all the research is indoors at this point, mostly in computers.

Greg Dalton: And do you think it should go outdoors, do you think that there should be real-life outdoor testing of this technology?

Ken Caldeira: I think with appropriate safeguards and oversight by appropriate governmental bodies there should be outdoor experimentation, but I don't think just rogue individuals should go out and do like some stuff.

Greg Dalton: Oliver Morton.

Oliver Morton: There’s a really interesting precedent which Ken was actually involved in. One of

the more radical ideas about removing carbon dioxide from the atmosphere was the idea that you could do it by stimulating plankton blooms in the southern oceans. This is my idea that was brought about partly because this is my idea about how ice ages might start and probably has a certain amount, not a complete but a certain amount of validity in that area. And people tried doing it and so they went out in southern oceans and well instrumented scientific experiments, dumped a lot of iron in so what happened, and it is true that there was increased photosynthesis not to the extent that they expected, and various complications.

But what's really heartening about this story is that people took the issue seriously. There is an international agreement about what you can and can't dump in the ocean. The people responsible for that took the advice of Ken and other people and started thinking about how to change the regulations to understand and take account of the scientific needs. And the scientific community decided that they didn't think that this really look like a particular effective way of sucking down carbon dioxide, though it's not a settled question. There were some people who like it; some people dislike it very much. But what I find interesting about this is that it was a kind of scary, weird idea that was tested and that was discussed, and that it was found that there were existing international rules for providing some level of governance. And so I think that's something, and I hope you feel proud of it, but don't you think that's something of a success story?

Ken Caldeira: I think there was some overreaction there but overall it was largely a success.

Greg Dalton: Ken Caldeira, you've been part of the research effort funded by Bill Gates. So tell us – he has a portfolio of investments, nuclear power et cetera.

And how does this fit into his strategy and what is Bill Gates been funding on geoengineering?

Ken Caldeira: Well, first let's just say that he along with his friends have raised $5 billion for investment in clean energy technologies. And so his investments in clean energy technologies are a thousand times larger than his investments in climate research of this sort. And so he funds by group largely and also David Keith's group and a few other efforts to do –

Greg Dalton: David Keith is a researcher now at Harvard.

Ken Caldeira: – to innovative climate and energy research, some of which is geoengineering related, but our work is all with computer models and trying to understand the consequences of different things people might do. A few years ago some of this money did go to fund the proof of concept for a sprayer that could potentially whiten marine clouds but that was all done indoors as a proof of concept. But again, his main effort is on trying to affect emissions reduction and he sees that there's a lack of research in this area and was hoping the governments would pick up the slack, but they haven't so far.

Greg Dalton: Oliver Morton, you write about Greenfinger. There is a scientist at the University of California, San Diego that writes about billionaires buying spaceships, et cetera. And Bill Gates, and in particular David Victor.

Oliver Morton: Oh David Victor yes, no David is a very insightful analyst of the political economy of energy. And David's worked a bit on climate geoengineering and he dubbed the idea that he created – he didn't create the idea but he dubbed this idea Goldfinger. And the idea is that the thing about putting particles into the upper atmosphere like a volcano does is that you don't have to be all flashy

and boomy and multi-megatony like a volcano to do that, you can do that with aircraft or with balloons maybe or something like that.

And this debate about how difficult it is, but it's not very difficult. And in an era when a man like Elon Musk can, you know, build a space fleet. The idea of building the capacity to alter the planet in a way in such a way just out of one person's capital is openly plausible. I mean the idea that it's possible, the idea that the political reality of the world would allow someone to do this without, you know, without shutting them down, that is a little bit less plausible to my mind. And Bill Gates gets pulled into this because it's known the Bill Gates funds is on geoengineering research with Ken and David's labs and a few other places. And so when you got a billionaire and you've got this idea that this is in an odd way cheap enough that a billionaire can do it. I remember hearing someone from Google once talking about a space mission. And he said, is this really expensive, or is this something that a guy like me can do?

Ken Caldeira: To give an idea of the scale of effort. It's estimated that the amount of flights that it would take to maintain an aerosol layer small particle layer in the stratosphere enough to offset all the warming expected this century would be about 1/1000 the size of the commercial aviation industry. So be about the number of flights each year that occur by commercial aviation every six or eight hours. So it's really a tiny economically, tiny cost to this.

Oliver Morton: And just might even be smaller than that because enough geoengineering to counteract everything, it's a very high amount of geoengineering. Especially if you're talking about geoengineering in some way being floated in on top of emissions reductions. That's not, you know, you don't want to reproduce the effect of a large volcano it would, I mean if you're talking about realistic scenarios down that line. You're talking about something actually yet more tenuous than that, yet easier.

Greg Dalton: So it's doable and so something that sounds like a science fiction novel. Kim Stanley Robinson, we're sitting here talking about and like, oh billionaire could do it with a few planes, not that big a deal. Your thoughts on how this something like science fiction is becoming closer and closer to simple possibility?

Kim Stanley Robinson: Well what we're telling is a science fiction story, a science fiction scenario and we're running several scenarios at once and they tend to get tangled. But the single person changing the world is a very old science fiction story, basically the rocket ship that you build in your backyard and go to the moon. So this is a really common kind of Horatio Alger story. But I think it will instantly get tangled with governance and will be something that the civilization at large can approve or disapprove can shoot down or whatever. There were problems with the geoengineering of just blocking sunlight in that if you keep on spewing out CO_2, a third to half of it ends up in the ocean. The ocean gets more acidic, if the ocean is more acidic it may lose the bottom of the food chain and then the rest of the food chain collapses also and that's a third of humanity's food. So we actually do need to decarbonize as well as these other things. And the solar geoengineering is a kind of an emergency science fiction story. What if the temperatures really began to spike? What if methane begins to get released to the atmosphere off of the ocean floor or the permafrost begins to melt such that the frozen carbon in the permafrost and methane begins to release fast and suddenly every year it's like 2 degrees hotter than the year before. And we are clearly reaching a moment of crossing one of those tipping points into a completely different planet, a jungle planet. At that point, then you say we need to put the dust in the air.

Oliver Morton: But that sort of scenario is the one that really concerned me. Because that's such a very common way of framing the story about geoengineering, that you hear the idea that it's like in case of emergency break glass sort of thing.

And a time when the earth is already going through severe climate changes and geopolitical panic is exactly the wrong time to launch a large planet-changing sort of effort. And it's very prone to, you know, the theory of emergencies that you get in Carl Schmitt and a lot of other places that, you know, he who makes the emergency makes the rule. It fundamentally challenges ideas about demographic or quasi or pseudo-demographic, democratic, why do I keep saying that? – Governments in the climate system. It seems to me that it's much, much wiser to talk about introducing small amounts of geo-engineering at a time when the world is not completely freaked out than large amounts of the time when it is.

Kim Stanley Robinson: Sure, but this is a – wiser means perhaps less likely to happen. When everybody would agree to do something is I think when after you have say the first food crisis, planetary food crisis, something severe enough to shock people. Before that it will be intensely argued and there will never be enough agreement for the world community to do it and then you get the idea of the Rambo individual doing it on their own. If you run the scenarios there's never a good one for geo-engineering unless you start talking about let's re-forest all the places that have been deforested. The Pacific Northwest, the Amazon, you can capture a hundred gigatons of carbon by reforesting. Let's try out geoengineering once over the Arctic. Let's us stabilize population. Let's capture the carbon that we're burning when we burn fossil fuels.

People are saying oh my God that would make energy twice as expensive as it is now as if that's a stopper. Energy is insanely cheap, it's too cheap. So you make it twice as expensive and your bill for the month goes from $10 to $20 and it's really only the big industries that are being hurt by this. It really only hurts quarterly profit and shareholder value. It doesn't –

Oliver Morton: There are one and half billion people who don't have access to electricity at all. Energy is not cheap to them and, you know –

Kim Stanley Robinson: But solar power has already become cheaper. If you didn't subsidize the carbon industry massively by taxpayer money, you already have the crossover power where clean energy could be quickly put in by government supported projects and it would be full employment, it would be a thing to do and you could have clean energy so much faster than we thought even 10 years ago.

Greg Dalton: Let's let Ken Caldeira get in here.

Ken Caldeira: And so first let's all posit that everybody on the stage would like to see clean energy economy as rapidly as possible, and we'll bring it back to geo-engineering. The same climate models that project all these terrible outcomes for global warming universally predict that those climate outcomes will be much less worse with solar geoengineering, applied at some reasonable level. And if you thought that we were eventually someday going to need it, the scenario that Oliver lays out where it slowly ramped in, where we sort of tiptoe into it would be the most environmentally responsible way to do it. Unfortunately, the most environmentally responsible way is also the most politically difficult and the political reality is closer to what Stan was saying where in an emergency situation there are model projections that suggest that mammals will not be able to survive outdoors, in the tropics because they won't be able to evaporatively cool themselves.

There is potential for widespread crop failure in the tropics today, heat stress on crops. And, so there is potential for widespread suffering and if that happens, the incentive – if there's a leader of a country whose people are starving and they think by injecting some particles in the stratosphere, they can feed their people and alleviate suffering, the political pressure to do that is going to be intense. And so, well I think Oliver's scenario would be the most environmentally responsible. I think Stan's scenario is the more plausible.

Greg Dalton: Oliver Morton.

Oliver Morton: It's by framing scenarios like this that we make things plausible and possible. And one thing that I object to about emergency framing is that it lets Ken and his colleagues off the hook because they are then able to study geoengineering saying "we don't really have to worry about responsible plausible politics because those are unlikely to happen. And if it's an emergency of course, we'll use something." I think that if you actually think that something is good and could reduce harm then you should be working on trying to reach and trying to reframe those politics from the get-go rather than saying, well we'll do this interesting side of a research – and it's fascinating side of a research, if I didn't think that I wouldn't have written a book about it. But you can't just so, but if you just do that and say, "Well the politics will only be the politics of the emergency and we can't have any say over that," then I think you're now to some extent ducking the issue.

Greg Dalton: And do you think that doing research also makes it more likely that once there's more money, more funding, more jobs, momentum that sort of researching something kind of puts it in motion to happening, Oliver Morton?

Oliver Morton: I think the people worry very much about technological lock-in. And at the same time governments put huge amounts of money into nuclear energy and you're seeing less and less about around the world. I don't think the argument that just because we research something it will necessarily happen. There are a lot of things, I mean, for instance, a lot of this work dates back to – has its like prehistory in debates about supersonic air transport in the 1960s and 70s.

In the 1960's everyone thought that the obvious next step for passenger air transport was to have supersonic planes. And my government and the French government actually did something about this, so did the Russians. The Americans talked about it and talked about what would be the effect on the stratosphere, putting lots of little particles up and that's why this is familiar. And decided and also thought about what will be the noise at ground level, it's like no that's not something we'll do. The idea that research necessarily leads to deployment; there are examples where it's the case because most things that end up deployed have been researched. But then a lot of examples where things have been researched and then quietly let go. And I'm – I don't think that there's any evidence that geoengineering is particularly pernicious in that respect.

Kim Stanley Robinson: I want to clarify that I like the idea of geoengineering because I think we're already doing it. And once we admit to it and begin to try to take control of it for good, we are in a more honest relationship with the planet. And I would agree that the best scenario would be to go ahead and try it out. And what's shocking about that is that trying it out is really the full thing. And that you put some dust in the atmosphere and see what happens to temperatures, and we know from volcanoes that really not that much experimentation is necessary; we know that it works at what it does. So and also I've seen the human terrain and the discussion in this civilization has changed so fast in the last 10 years that even now us talking is changing the perception of what geoengineering is and how acceptable it might be. Ten years ago we couldn't have had this conversation but the 10 hottest years that we have on record took place in this century. So global warming is happening and everybody knows it. The denialists are now just a fraction of the power that they had in the society 10 years ago. They're going to slink away from this and pretend they never said it, and we are going to be in a world of global warming.

And geoengineering is going to be something that's talked about more and more and it may happen in the good scenario rather than the emergency where once you have a food crisis, everybody's going to be behaving with that level of craziness that won't be good for any human decision.

Greg Dalton: Although there is some recent evidence recently that the more the scientific evidence

has consolidated around climate change, the more deniers and actually I'm not so sure that denial has been gone down as the scientific consensus has advanced.

If you're just joining us, our guests today at Climate One, Kim Stanley Robinson, a scientific author – science fiction author. Oliver Morton, Briefings Editor at The Economist and Ken Caldeira from the Carnegie Institution for Science at Stanford. I'm Greg Dalton. We'll be right back after this break.

[Climate One Minute]

Announcer: And now, here's a Climate One Minute.

Bill Gates, Elon Musk and other high rollers have thrown billions of research dollars into areas they're passionate about: clean energy, space travel, geoengineering. But should we be letting billionaires pick up the tab, rather than the government? Climate scientist Jane Long says that relying on private funding can lead to risky science. When it comes to experimenting with our atmosphere, she says, the government should be holding the purse strings.

Jane Long: *The kinds of thought experiments and workshops and things that are being done through private funding, I have no problem….*

Announcer: Jane Long is co-chair of the Task Force on Geoengineering at the Bipartisan Policy Center. She spoke with Climate One in 2015. Now, back to Greg Dalton and his guests at The Commonwealth Club.

[End Climate One Minute]

Greg Dalton: And it's time for our lightning round. I'm gonna ask each of you a yes or no question starting with Kim Stanley Robinson. For-profit research into geoengineering is a serious public concern? For-profit research, the profit motive.

Kim Stanley Robinson: Is a serious public concern? I would say no, it's not a serious public concern.

Greg Dalton: They're not concern about people making – okay, fine.

[Laughter]

This is yes or no.

Oliver Morton: Lightning has struck, Stan!

Kim Stanley Robinson: No. But wait, the question is poorly formed. Sorry, but I misunderstood the question. It shouldn't be for profit, that's stupid. It should be for the public good, it should be a public utility and of the people by the people and for the people as a government action.

Greg Dalton: Oliver Morton, the CIA is working on geoengineering?

Oliver Morton: Well the CIA funds, has funded research on geoengineering that's – or funded reports on research on geoengineering. That's absolutely true. But whether it – I have no reason to believe that it's actually working on doing it itself.

Greg Dalton: They'll hire other people. Ken Caldeira, if China can hack the Pentagon, they can hack

the sky?

Ken Caldeira: Yes.

Greg Dalton: Kim Stanley Robinson, you are a liberal who loves the US Navy?

Kim Stanley Robinson: Yes. Except I'm a radical who loves the U.S. Navy, but yes.

Greg Dalton: You also like GMOs?

Kim Stanley Robinson: I do. You betcha.

Greg Dalton: Oliver Morton, Kim Stanley Robinson's science fiction is coming uncomfortably close to becoming reality?

Oliver Morton: Well, I reject the premise of that one, I will stand on this. I think there is a foolish attempt by people to suggest that science fiction and reality are in some ways opposed. I live in the science fictional reality. There is a robot on Mars blasting things with laser beams as we speak. The idea that this is not science - there's a guy just there who laughed, and makes spacecraft a few blocks south of Market, right? The idea that we are not living in a science fictional world is just preposterous! Of course I mean Stan's work is part of the world that we live in, but there's no contradiction there.

Greg Dalton: Planet Labs makes low grid, yeah satellites here in San Francisco. Ken Caldeira, carbon dioxide cuts today have basically no effect on the climate for 30 years?

Kim Stanley Robinson: Lightning!

[Laughter]

Ken Caldeira: I'll say no then.

Greg Dalton: You did a lot better than an MIT professor who runs the Energy Department who was here a couple days ago. He had trouble with yes or no. Ken Caldeira, you'll be happy when this lightning round is over?

Ken Caldeira: Yes.

Greg Dalton: Alright, it's over. Alright here it is. I'd like to ask each of you, when you think about geoengineering, Kim Stanley Robinson, what gives you fear?

Kim Stanley Robinson: That people will do the thing they maybe do with the idea that humanity could live on Mars or on some other planet. That they will take less seriously the responsibility to decarbonize fast.

Greg Dalton: Oliver Morton, what gives you fear when you think about the prospect for geoengineering?

Oliver Morton: Well, I think the biggest risks of entailed in relatively small-scale solar geoengineering of the sort we've been talking about. The big risks are geopolitical rather than geophysical in my mind. And what worries me about almost all geopolitical risks, is nuclear weapons. And I find it extraordinary that I read people say that geoengineering provides an unparalleled threat to human existence and it's something unlike anything else we've ever done. We

build machines that can end civilization and set them loose in the oceans, I mean not uncontrolled obviously. But the idea of the geoengineering is a problem that's somehow vaster than the ability we have to start and end nuclear wars, it doesn't make sense to me. So, nuclear war is what worries me about geoengineering.

Greg Dalton: Ken Caldeira?

Ken Caldeira: I think my fear is that the same lack of thoughtful societal deliberation that we're applying to GMOs and healthcare and policy in many areas will also extend to the discussion of geoengineering. It seems that we've devolved into a period where tribalism trumps careful analysis of empirical evidence. And I think unless we can make political decisions based on sound information our society is in big trouble.

Greg Dalton: Oliver Morton, you write that planet-speak weakens the ties between the nature and humans and makes the planet as this abstract geophysical entity. And that talking about the planet, distance is the – that's a problem, talk about that.

Oliver Morton: Yes, I do say that. So not surprising I agree with it.

[Laughter]

On Wednesdays and Thursdays on other day. Yes, the idea of the planet, that very powerful icon for the environmental movement of the planet floating in space, it's extremely powerful. But it's also strangely alienating because it takes us out of the involvement that's nurturing us and that we are changing. And that has a – there's a lot of modernist thought, that's similar to this and it leads to this strange paradox to me that as we see, we feel ourselves divorcing from nature to some extent, living a more urban lifestyle, living with more high-tech food these sort of things living with high energy – we are in a strange hidden way becoming much more intimate with nature. Because there is a sense in the preindustrial age where you can make a sort of like reasonable distinction between the human and the natural. But when you think that, for instance, due to nitrogen artificial nitrogen and fertilizers 40% of the nitrogen atoms in your body come from a factory, that's the sort of thing that makes you realize there is a big intimate interconnection between what it is to be human and what it is to be part of the planet.

But we kind of lose when we see the planet over there and us over here behind the moon looking at it and saying oh we have a duty to this poor little fragile planet. And that's not the way to think about it. We are inside it. One of the strongest images of the planet, the images of the planet that I keep coming back to the moment are the images that you get in the paintings of Turner where you can't see where the industry and where the weather and where the human activity begin and end, where your whole perspective is within the movements and the motions of this great engine.

Greg Dalton: Kim Stanley Robinson, let's turn to Hollywood popular culture. There's been a number of films recently, going back to The Day After Tomorrow about 10 years ago, which talked about the changing Arctic currents and kind of like Super Storm Sandy hitting New York. There's been others; Matt Damon seems to go to different planets all the time. Snowpiercer was a movie –

Oliver Morton: Never works out well for him though, don't you think?

Greg Dalton: Yeah, and Snowpiercer was a film about geoengineering gone wrong. Tell us about the portrayal in popular culture of these concepts.

Kim Stanley Robinson: Well, I've dealt with it myself and it's a difficult narrative problem because climate change is going to take place over decades or centuries. And so you want your narrative to take place over days or at most months. And indeed for me I can speak for myself and it happened with this movie The Day After Tomorrow. When they analyzed the Greenland ice core data they saw that the Younger Dryas, where we went from a warm and wet world into a cold dry world had happened in about three years. And they postulated that perhaps the Gulf Stream had shut down because of fresh water on its surface and that this explained it, and all this scientific work and explanation of peculiar data gave us the idea of abrupt climate change. And then I had my story and so did The Day After Tomorrow. You can tell a story that takes place in three years and it's a frightening one, but it also allows you to get narrative traction on it. So and also telling the story of things going wrong is inherently more dramatic than the story of things going right and as a Utopian science fiction writer I've dealt with that one also. So there are several problems for the way that we tell stories to be able to engage with climate change.

Greg Dalton: Oliver Morton is the Briefings Editor at The Economist. Other guests today at Climate One are Ken Caldeira, a Climate Scientist from the Carnegie Institution at Stanford and Kim Stanley Robinson, author of science fiction. I'm Greg Dalton. .

Let's go to our audience questions. Welcome to Climate One.

Matt Stewart: Hi, my name is Matt Stewart I'm wondering if you were put in charge today, let's say the United States and we didn't have a crazy congress, you can may be able to get something through and were running for president - what would you do with geoengineering right away?

Greg Dalton: Oliver, you're British, you're not getting this one unless you'd like to, yeah, come back as a British sovereign, but I don't know. Ken Caldeira?

Ken Caldeira: Well, I don't want to be too self-serving, but as a research scientist, I have to say that I'm in favor of increased research. And so, you know, I would greatly increase the research budgets but engage in the research in a way that has a lot of public input and international collaboration.

Greg Dalton: Kim Stanley Robinson, any thoughts or input?

Kim Stanley Robinson: You'd pay a hundred science fiction novelists to write science fiction novels –

[Laughter]

Oliver Morton: And obviously I would employ many journalists.

[Laughter]

I think the most important thing would be to say this is something we need to learn about and talk about, but we need – as America has the greatest scientific infrastructure in the world, we can learn a lot about it and we can take a strong role in that but we are not gonna be leaders of the world in discussing how to use this. We're gonna put this knowledge at the disposal of our friends and colleagues around the world in order to have a discussion that is worthwhile having.

Greg Dalton: But, Oliver Morton, you're the environmental editor at The Economist. Many environmentalists think that this even having this discussion is harmful and counterproductive to their ends.

Oliver Morton: That's certainly true because there's and various reasons for that. And one of them

is that they don't feel that this addresses the ultimate goals of the problem. And there's obviously truth in that. And I think that it's very important as I've said before in this conversation to address carbon dioxide emissions as well as to talk about this. So stuff let alone to do this sort of stuff. But one of the underlying causes of the problem is not addressing the problem. And so in a sense by addressing the problem, one of the things you do is at least you address the problem have a story out that is getting told about what you can actually do.

Kim Stanley Robinson: Can I add?

Greg Dalton: Kim Stanley Robinson.

Kim Stanley Robinson: And since you're postulating a kind of a kingly moment – a carbon tax that increases over time, a solar credit so that people could put solar photovoltaic and solar water heating. And also full employment; everybody gets a job that once when in landscape restoration and in creation of wetlands, creation of reforesting the deforested areas. Lot of work to be done and so these things are specific policies that could really help in this situation.

Greg Dalton: We're talking about geoengineering at Climate One. Geoengineering being the idea of bouncing sunlight, sun power from the sky back out into outer space using various technological means. Let's go to our next question. Welcome.

Joe Mascaro: No kidding, outer space. So I'm Joe Mascaro from Planet Labs; we launch small satellites for earth observation. My question is about our perception of how human civilization interacts with our biosphere. I think historically, we've thought of human civilization as something nested within the biosphere. And that is no longer true. I mean already we have a portion of human civilization living on the Martian surface in the form of the Opportunity and Curiosity rovers. We have the space station. How do you think that we ought to recalibrate our perception of the moral considerations of geoengineering with respect to the fact that we clearly already today have a civilization that exceeds the scope geographically of our biosphere?

Greg Dalton: Who'd like to tackle that one? Ken Caldeira.

Ken Caldeira: These guys give better answers than me but I'm kind of a Luddite actually on this one, in that I would like to see humans withdraw to as compact an area as possible and allow wilderness to flourish in the rest of the planet, that's my Utopic vision and –

Oliver Morton: That's not being a Luddite, that's just being an American. And, you know, many of my best friends, well I live in a country which has parts of it which are extraordinarily beautiful, no part of which can be reasonably described as a wilderness. And we're discussing creating, discussing creating radical novel ecosystems to make it more beautiful. I find the idea that the humans must be a small set aside part in a great wilderness, I understand the power of that idea, but I think you have to realize it's a very culturally specific idea.

Greg Dalton: Kim Stanley Robinson, retreat, sort of restore balance of human and nature?

Kim Stanley Robinson: No, but space science is an earth science and the solar system is our neighborhood. And when we talk about Mars, we are thinking about planets, and when we think about planets we're realizing we're on a planet and so it's all good in that regard. And we, this is the only planet we can live on and stay healthy and I think that will be true for tens of thousands of years. So there is no Planet B and that moral hazard is taken away as soon as you understand that. But studying these other places, sending robots with cameras and sending people as scientific stations the way we sent people to Antarctica a century ago, it's all fantastically interesting and

exciting and useful and beautiful.

Greg Dalton: Let's go to our next audience question. Welcome.

Mark Harnett: Hi, I'm Mark Harnett. Is there a way to test the solar engineering at a local level? Once you put the stuff into the stratosphere, does it necessarily affect the whole planet? And then who do you think is going to do it first and when?

Oliver Morton: There's no way to test as it were sort of like a planetary effect without getting apparent effect. The ways to – you could test some of the side effects by doing small experiments. You could test some of the what happens to the chemistry and physics of the upper atmosphere when you put this in. Some people have suggested that you might be able to do short-term effects on something like a heat wave, but in general this is a planetary sort of phenomenon and you probably, you will not know exactly what you get until you get it. But that's also true of non-deliberate climate change. I mean the models that tell you what to expect under increased greenhouse warming are the same models as the models that tell you what to expect under greenhouse warming plus geoengineering. And then they get no less accurate when you add in the geoengineering. In fact we may not want to go into this now but Ken's occasioned to me that they're possibly more accurate when they deal with geoengineering and global warming than global warming alone.

Greg Dalton: Ken Caldeira, could this be tested regionally? There are some suggestions for along the California coast or other places.

Ken Caldeira: First to reiterate what Oliver said, that there – one reason to do experiments is to learn about local process effects. But there have been proposals which have not yet been evaluated that for example a fine mist could be created off the coast of California that would then cool the ocean and increase the amount of coastal fog which is dissipating as the planet continues to warm. And the California coastal redwoods depend on this fog for the water so not all that water goes up the trunk; some of it is getting absorbed by the leaves. And if this fog goes away a lot of the coastal redwoods could go away. And so it's been suggested that a fine spray might be able to maintain the coastal redwoods. Similarly, if the oceans cooled off in this way there's, it's likely that an increased cool moist sea breeze could come into the desert southwest; at least it's possible.

And the idea that by spraying some seawater in the air that you might be able to cool off what will become an increasingly parched region might become attractive. And so these are still in the realm of speculation, but I think it's the kind of thing that people would like to understand better.

Oliver Morton: Those would be projects thought that weren't aimed in and of themselves at changing the global climate. Though if you added such projects together across the face of the globe, you would have a global change but then that's very hard to predict what would actually happen.

Greg Dalton: Let's go to our next question.

Jessica Lovering: Hi, I'm Jessica Lovering from the Breakthrough Institute. I have an opposing hypothetical geoengineering experiment. So supposed, we're really successful at deploying clean energy, shutting down coal plants, providing people electricity so they stop burning wood and dung. We'd have a dramatic decrease in particulate emissions which could cause a short-term dramatic warming. Is that something that's studied or is it so unfeasible that we'd actually do it that it's not of a concern?

Greg Dalton: Ken Caldeira, shutting down coal plants could make the world hotter?

Ken Caldeira: Yes. Coal plants today, I don't have the exact number off the top of my head, but some substantial fraction, probably over half the warming that's caused by our carbon dioxide emissions is offset by sulfur coming out of coal plants largely from Asian coal plants. And if those were shut down instantaneously, the planet would warm up substantially.

And if the Chinese, as they shut down their coal plants maybe took 5% of that sulfur and put it higher in the atmosphere they would maintain that cooling. And so this idea that maybe we're already admitting sulfur into the atmosphere and cooling earth through the burning of coal and that could be maybe done more thoughtfully and reduce those emissions by 95% but still get the same cooling effect.

Greg Dalton: Let’s go to our next question. Welcome.

Male Participant: Hi. When we talk about geoengineering, we hear a lot about the atmosphere. My question is would geoengineering be important or begin at the ocean level, and do we adequately understand enough about how oceans affect climate and ocean processes affect the climate?

Greg Dalton: Ken Caldeira, you’ve written about this.

Ken Caldeira: Yeah, well we, one proposal which we vetted in some models simulations last year. The deep ocean is very cold on average; it's less than 40 degrees Fahrenheit. And so one idea to cool the earth is to bring some of this cold water up to the surface and then take this warm water at the surface and stuff it down into the deep ocean. And what we found in our simulations is that this warm surface water also helps maintain the clouds and when this cold water was brought up, the clouds went away, and then the sun warmed this dark ocean surface. And by the end of the century the planet was warmer than it would've been had we never attempted doing this. And so people are thinking about various ocean interventions just from a modeling point of view but so far, I would say the proposals, at least the proposals that we've looked at, haven’t been very promising.

Oliver Morton: It’s really interesting in the way that the ocean has this huge control and effect on climate. And yet the atmosphere gets all the attention that’s right because the atmosphere is easier to change. And the atmosphere is a kind of small thing, right? It’s about the same mass as the Mediterranean Sea. It’s tiny compared to the oceans. And that's why even that's why industrial civilization is able to change the climate so much it’s because the atmosphere is actually quite small. I just find that a very telling idea. It's like, it provides a certain amount of leverage and it’s hard to find other levers to move the ocean around with other than the atmosphere.

Greg Dalton: We had Sylvia Earle here last year, there’s a podcast on Climate One.org and iTunes. She talked about how oceans eloquently drive the climate rather than people think the other way around, that the atmosphere affects the oceans; it’s the oceans that drive weather and climate. Ken Caldeira.

Ken Caldeira: If you compress the atmosphere down to the density of water it's only about 30 feet deep. And so one way to think of all the pollution we’re putting into the atmosphere, it’s like putting it into a lake that's 30 feet deep. And so it's understandable that we can, pollution will accumulate and have substantial effects.

Greg Dalton: Ken Caldeira is a Climate Scientist at Stanford. We’re also talking with Oliver Morton, from The Economist magazine and Kim Stanley Robinson, the science fiction author.

Greg Dalton: We’re getting close to the end. I want to ask you what an average person listening to this can do to have an influence, not to get involved in geoengineering in their backyard, but what an

average person can do Ken Caldeira, to have a positive influence and I'm gonna wrap up with one last question to each of you.

Ken Caldeira: Well, it's good for people to reduce their own carbon footprints and so on. I think really this is a political problem that will be solved by changing our entire energy and transportation infrastructures. And so I think the most important thing that people can do is let their elected representatives know that their votes depend on them supporting sound climate policy.

Greg Dalton: Democracy will solve the problem. Oliver Morton, what can an average person do?

Oliver Morton: I'm not particularly enamored of these ideas of incremental action because I think it lets the political system off the hook. I think that the problem is that to some extent if people of goodwill act and people not of goodwill don't act, then you don't have a solution to the problem. The idea – this is why politics is absolutely fundamentalist. The idea is to find things that people who disagree about a lot can agree on doing, and that's political process. So I would say to some extent - again, that's political, a political answer. But I would also say you should get interested in the processes of the earth. Geoengineering is about changing process of the earth. You live on an extraordinary planet and we understand that planet far better than we ever have before. And simply trying to partake of some of that understanding with the spirit of reverence and a spirit of awe to the extent that you want, but also with the spirit of fascination and wonder at the mechanisms involved. I think that's both politically useful and I think it's life enhancing. So I think that's what people should do.

Greg Dalton: Watch those David Attenborough documentaries. Kim Stanley Robinson, you came down here from Sacramento on the train today. What else can people do, average people to have an impact?

Kim Stanley Robinson: Keep a garden, compost. Ride a bike, work outdoors. Vote leftist, don't believe in the capitalist system. The market system is actually causing the mass extinction event, so there's not really a market solution. We actually need post-capitalism. So think post-capitalism, what is that? It's mysterious, you Google it you get nothing, that's in itself remarkable because we need it bad.

Greg Dalton: I can't resist, we have a very market-based person over here from –

Oliver Morton: A man that works for a very market-based magazine. But I would also point out as many people including *[unintelligible]* point out: there is a difference between markets and capitalism.

Greg Dalton: Are markets part of the problem or part of the solution or both, Oliver Morton?

Oliver Morton: Markets can be part of some of the solution but markets are not a solution. No market solution will be articulated through geoengineering or rather, no geoengineering solution I think will be articulated through the market.

Greg Dalton: We have to wrap it up there. We've been talking about geoengineering, the idea of bouncing sun's radiation back up into the sky and other means, here at Climate One at the Commonwealth Club with Kim Stanley Robinson, the science fiction author, Oliver Morton from The Economist and Ken Caldeira, a climate scientist at Stanford. I'm Greg Dalton. You can join the conversation on Twitter using our handle @climateone and listen to the podcast of this and other programs on our website climateone.org. Thanks to the audience here in the room at the Commonwealth Club and online and on air. Thank you all and thank our guests.

[Applause]

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