#1594 Testing New Climate Solutions: Geothermal and Geo-Engineering

JAY TOMLINSON - HOST, BEST OF THE LEFT: [00:00:00] During today's episode, I'm going to be telling you about a show I think you should check out: it's the *Talking Politics and Religion Without Killing Each Other* podcast. And come to think of it, I probably should've promoted that before Thanksgiving. But anyway, take a moment to hear what I have to say about them in the middle of the show, and then listen wherever you get your podcasts.

And now, welcome to this episode of the award-winning *Best of the Left* podcast. As the hottest year in about 125,000 years or so begins to come to a close, we turn to two projects still in their infancy that have big plans to decarbonize our electricity generation on one hand, and give us a bit more time to turn our climate futures around on the other.

The first is a reinvigoration of the geothermal power industry, with the hopes of scaling up globally. And the second is geoengineering, which aims to reduce the solar radiation hitting the planet, [00:01:00] to reduce devastating climate impacts while the world finishes up the work of going carbon neutral. Both ideas are a little scary. Either or both could be brilliant or disastrous. But the two things that are clear to me are that failure in the face of climate chaos will definitely be disastrous, and any ideas with a reasonable chance of helping deserve further study.

Sources today include *PBS Terra*, *Vox*, a *TED Talk* from Jamie C. Beard, the *vlogbrothers*, *Volts* and *Radiolab*. And I will close the show today with an interview with climate activist Mike Tidwell to get a bit further into some of the arguments and counter-arguments surrounding geoengineering, and members will get an extended version of that interview.

Have We Made ANY Progress on Climate Change? Here's The Data, You Decide - PBS Terra - Air Date 12-20-22

MAIYA MAY - HOST, WEATHERED: With all the bad and often terrifying news about climate change, doomsday may seem like it's just around the corner.

But is it? There are electric cars, [00:02:00] solar panels, and wind turbines everywhere. Still, we've wasted a lot of time arguing over if and why global warming is even real, let alone a priority.

So, how are we doing? Well, in the early 2010s, a set of emissions scenarios called RCPs, ranging from very stringent climate policy to no climate policy at all, was developed to represent what warming could look like by 2100. To get an idea of how we're doing, we asked experts in the field which one of these scenarios looks most likely today.

These scenarios were developed in the wake of the global financial crisis when emissions dropped for the first time in the history of many developed countries. But by 2010, they had begun to rebound along with the economy, and developing countries with enormous populations like China and India were planning massive investment coal plants to power economic growth for billions of people.

SEAVER WANG: If you had asked me 10 years ago [00:03:00] whether I thought we would be in the place we are today, I would've thought that it would've been very unlikely. I would've thought that there's no way that that that's possible.

MAIYA MAY - HOST, WEATHERED: So where are we today? And where are we going? The RCP origin story can help us understand.

ZEKE HAUSFATHER: Back in the lead up to the IPCC Fifth Assessment Report that came out in 2013, the energy modeling community developed four pathways, which were essentially four different possible warming outcomes at the end of the century.

SEAVER WANG: Now, the representative concentration pathways all come with a number. For example, RCP 2.6, RCP 4.5, or RCP 8.5. That number is essentially the imbalance in Earth's energy budget resulting from human influence on climate. And that number is expressed in watts per meter squared.

MAIYA MAY - HOST, WEATHERED: So in the case of RCP 8.5, this means that humans would have emitted enough greenhouse gases into the atmosphere to add an additional 8.5 watts per meter squared of solar radiation into the [00:04:00] climate by 2100.

And considering how many square meters are on Earth's surface, that's a lot of watts. This many, to be exact, each of the RCP levels projects an estimated

average of global warming. RCP 8.5 is close to 5 degrees. RCP 4.5 is just below 3 degrees and RCP 2.6 represents the Paris Agreement goal of limiting warming to well below 2 degrees.

RCP 8.5 with its associated 5 degrees of warming is truly an apocalyptic scenario. It means game over. An existential threat. It models a world with no climate policy. And it's hard to argue that we had or have an effective climate policy either domestically or internationally.

ZEKE HAUSFATHER: Because RCP .5 was the only one of the RCPs run with no climate policy, a lot of people started referring to it as "business as usual," or in a world without climate policy, we'll have five [00:05:00] degrees of warming.

SEAVER WANG: Emissions were just increasing year after year after year. There was the Kyoto Protocol in 1992, and it was widely considered to have been a failure. It really seemed feasible that we could end up on a pathway where coal use would continue to expand, where we would continue to prioritize fossil fuel economic growth throughout the remainder of the century.

MAIYA MAY - HOST, WEATHERED: And a real problem seemed to emerge with reducing emissions. So far in the 20th century, increasing carbon emissions had been correlated with increasing gross domestic product, and even reducing poverty. China's emissions were growing very fast along with their economy, and even with all the problems associated with rapid development, they were lifting citizens out of poverty.

Other developing nations hoped to follow their lead, and coal was the fuel of choice. Could the developed world, comparatively rich after more than a century of burning fossil [00:06:00] fuels, really asked them to give up on coal?

And that's when something very important changed. In the 2008 global financial crisis, the emissions of many developed countries did what they had always done: they followed the economy, downward this time. But then economies rebounded. After a brief uptick, the emissions of large carbon polluters like the US, EU, and Japan surprisingly continued to fall, even in a world with no functioning climate policy. And GDP continued to rise.

ZEKE HAUSFATHER: We're not in "business as usual" anymore, or at least business as usual has changed.

MAIYA MAY - HOST, WEATHERED: So what exactly changed, and should we still call RCP 8.5 "business as usual"?

ZEKE HAUSFATHER: RCP 8.5 is very much a world dominated by coal. By 2100, global coal use has increased six fold above 2010 levels, and global emissions have tripled. In the real world, global coal use has been flat, if not slightly declining, [00:07:00] since 2014. Clean energy costs have fallen dramatically, solar is 90 percent cheaper in the last decade, wind is 66 percent cheaper, batteries are 90 percent cheaper, electric vehicles are about 14 percent of new vehicle sales globally now, and upwards of 20 percent in places like China and Europe.

And so, we're having an energy transition that was not accounted for in these worst case scenarios a decade ago.

MAIYA MAY - HOST, WEATHERED: Seaver described this transition as one where activists, advocates, and even scientists pushed for emission reductions. No one got exactly what they wanted, but there was just enough government and society support to create a tailwind for innovators, even while the US was busy pulling out of international agreements.

SEAVER WANG: You can't really disentangle state policies from real acceleration in private sector clean energy. It was actually because of early subsidy programs in Japan, in Germany, and in China in particular, to help fill in the gap between what was economically [00:08:00] feasible and what needed to happen.

MAIYA MAY - HOST, WEATHERED: This is all extremely good news. And we're no longer in a no climate policy world. At least, not entirely. In 2015, the Paris Agreement was signed creating voluntary benchmarks for countries to meet in order to stay well below 2 degrees of warming or RCP 2.6. However, almost no countries are actually on target to meet their benchmarks, and the four largest emitters have a long way to go to even get close. So at this point our RCP 2.6 is also not very likely.

ZEKE HAUSFATHER: And so that's the reason why we think now that the world is probably headed toward a bit under 3 degrees under current policies and technological development, rather than close to 5 degrees, where some people thought we were headed.

MAIYA MAY - HOST, WEATHERED: But even if 2 degrees of warming is still hugely ambitious, isn't it cause for celebration that we've come so far from the old projections of 5 degrees?

ZEKE HAUSFATHER: You know, it's probably not [00:09:00] literally the end of the world. I think humanity could survive in a world of three degrees, but it's not a world we want to leave to our children.

Batteries are dirty. Geothermal power can help. - Vox - Air Date 11-1-22

CHRISTINA THORNELL - HOST, VOX: Indonesia has the world's largest proven nickel reserves. Most of them are found here. So is a large concentration of the country's nickel processing plants. A lot of this nickel supplies the steel industry, but most of the growth the industry has seen in recent years is driven by the demand for EV batteries, demand that's predicted to skyrocket.

To extract the nickel, the rocks have to be smelted at really high heats. And that energy is almost exclusively provided by coal-fired plants that spew greenhouse gases and pollute the air.

Nickel is essential for a green future, but using coal-fired plants isn't actually necessary, especially in Indonesia. . Indonesia sits along the Pacific Ocean's Ring of Fire, a stretch of hundreds of active volcanoes that sit on top of pools of hot magma. We only really see the immense power of this heat when it pierces through the Earth's surface. [00:10:00] But when it's close to the surface, that magma also heats the water trapped beneath the Earth. That hot water can provide a continuous and renewable flow of energy called geothermal energy. To capture that energy, we need to drill down to reach underground water. Then, hot water, or steam, rise up to a well.

In a power plant, that hot water is often used to heat a different liquid that is then vaporized and used to turn a turbine to generate electricity. Meanwhile, the clean water extracted is funneled back into the ground where the earth's magma reheats it once again.

PATRICK DOBSON: And that fluid is recycled. So there are no emissions of any gases to the atmosphere. In that sense, it's a completely green, carbon-free energy source.

CHRISTINA THORNELL - HOST, VOX: Plus, it doesn't rely on the weather like wind or solar energy do. Indonesia is the second largest geothermal producer in the world. On the same island where coal-fired plants are powering nickel production, there's a [00:11:00] plant tapping into geothermal power. There are about 20 active geothermal plants. There are also tens of sites explored for development.

One of the biggest things holding geothermal back in Indonesia, and other parts of the world, is cost.

PATRICK DOBSON: And once you've got evidence that there's a resource, the idea is then to figure out how big is the resource, how hot is the resource, and how much would it cost to develop that type of resource. Longer timeline, higher risk factor, and higher initial investment costs are all things that make geothermal more challenging to put online.

CHRISTINA THORNELL - HOST, VOX: And while geothermal maps like this one can help identify possible hotspots, you never know what you're going to find until you actually drill. Over time, the hope is that geothermal exploration will become cheaper, more predictable, and so efficient that it'll bring the costs down.. But it can be tough to change an existing industry, especially if there's a lot of money in it.

Encouraged by Indonesia's push to attract foreign investment and deregulation of [00:12:00] environmental protections, Chinese companies have invested or committed about $30 billion to nickel plants in Indonesia. Particularly in Morowali, where new coal-fired plants like this one are being built to power the investment.

For people like Esvina, the fact that geothermal doesn't produce emissions or air pollution could make it the solution they are looking for. Because if nothing changes, they might have to leave their homes.

Today, geothermal plants are mostly confined to volcanic areas. But our EV batteries are made of metals and minerals from around the world. And about 60 percent of the energy we use to process them comes from fossil fuels. There's enormous potential for cleaner EV battery production in all these yellow and red regions if we dig deeper and find ways to tap into the underground heat, whether there's underground water or not.

Like every new resource, the work we do to harness it requires careful consideration.

PATRICK DOBSON: How do you preserve parklands and how does that coexist with geothermal [00:13:00] development?

CHRISTINA THORNELL - HOST, VOX: The other issue that seems to come up a lot when I read about geothermal is seismic

activity.

PATRICK DOBSON: Most of the geothermal-induced seismicity that occurs is very low level seismicity, but the goal is to not have significant seismicity that could cause damage and distress to local communities. The challenges are to make these environmentally, socially and economically viable.

CHRISTINA THORNELL - HOST, VOX: And that's a very important challenge, especially if we think of geothermal as a solution to clean up the supply chain that powers our green energy. Because all too often, it's poor and marginalized communities who live next to power plants, smelters, mines, factories, pipelines, waste plants. As we move towards a better future, it's important to make sure it isn't just green, but fair.

The Untapped Energy Source That Could Power the Planet | Jamie C. Beard - TED - Air Date 10-28-21

JAMIE C. BEARD: We have Engineered Geothermal Systems, or EGS. In this concept, several wells are drilled. At the bottom of the well, the rock is fractured. It creates a [00:14:00] reservoir under the surface. Think of it as a pot where you boil your water underground, right? You send a fluid down, it percolates through the fractures, it comes back up really hot, and we use it for all sorts of interesting and important things, like heating buildings directly, or we can run it through a turbine to produce electricity.

Now, EGS can take a lot of forms. This is an area of intense innovation right now. You can engineer these systems in a variety of ways, but the basic concepts stay the same.

Then we have closed loop systems. Closed loops are pretty new. It's another really hot area of innovation. Same concept, basic as EGS. You have one or more wells drilled, you create a reservoir underground, but in closed loops, instead of fracturing to create that reservoir underground, it's entirely drilled,

like a radiator in the rock. And they take many forms, too, just like EGS. Check it out. You can see in closed loop systems how useful it is to be able to turn and steer that drill bit, totally enabling in terms of getting these concepts to work.

Another really [00:15:00] cool aspect of closed loop systems, another fierce area of innovation right now, is what we're putting in these systems as the working fluid to harvest the heat. Most of the time, it's water. But what if we could optimize a fluid to perform better than water, so it heats up faster than water at lower temperatures than water?

And the really cool thing about closed loops is the going candidate, one everybody loves right now to put in these systems to most efficiently harvest heat, is actually a substance that's the center of our climate angst right now. It's around us in excess and abundance. It's CO2. Super cool!

So then there's hybrids -- not the cars -- geothermal hybrids. You take the best of both worlds. You get the increased surface area and heat that you get from fracturing rock. You combine that with a closed loop well design so you can use that optimized fluid. The goal of hybrid systems is to extract the [00:16:00] most heat, minimize drilling costs.

So that's what's happening right now, a lot of innovation. It's really, really cool. But these concepts, none of them are without their technology challenges. But y'all, these are not moonshots. They are not moonshots. We are talking about making very incremental changes to existing technologies, methods and techniques, with an eye on more, hotter and deeper geothermal development.

And these also aren't just ideas. There are teams right now in the field demonstrating these concepts. Teams like Sage Geosystems, a team that I mentor. This is a well that they are demonstrating this summer in -- get this -- Texas. Not in Iceland, not on the side of a volcano, not in the Ring of Fire. This is a Texas pasture where you would never suspect the enormous geothermal resources that [00:17:00] lie below. And this well is an existing abandoned oil and gas well that they have repurposed for this geothermal demonstration. If all goes well with this demonstration, by 2022 -- that is next year -- they will have a geothermal power plant in Texas.

There are dozens of examples like this right now in the field. These are all startups. They're out there proving geothermal concepts. New technologies, new drilling, the concepts that I showed you in the slides. We are in the midst of a geothermal renaissance. In the past 18 months, more geothermal startups have launched than in the past 10 years combined. If even one of these startups is

successful at proving a scalable geothermal concept, we are literally off to the races in developing this massive, reliable, 24/7 clean energy source anywhere in the world. And by off to the races, I mean that, right? [00:18:00] Like, we gotta go. The clock is ticking, we need scale. It's gonna be cute if it works, but we've got to have global scale.

So how do we do that? It brings me to my proposition. So, it turns out that there's an industry that is perfectly positioned to take us from the few geothermal power plants we have today to the hundreds of thousands that we need to meet demand. The industry that everyone loves to hate, who cares about the environment and climate, is that industry. To scale geothermal, what do we need to do? We need to efficiently, effectively, and safely drill below the surface over and over and over and over again. And who does that now? The oil and gas industry does that now.

The oil and gas industry is a global, specialized workforce of millions, backed by almost [00:19:00] 200 years of breakthrough technological innovation, all aimed at exploring for, drilling for, and producing energy from deep underground. You flip the switch, and you have green drilling. And oil and gas keeps its current business model, the business model that keeps them firmly rooted in hydrocarbons now.

They're doing what they know how to do, which is exploring for, drilling for and producing a subsurface energy asset. But what we're talking about here is a pivot, from hydrocarbons to heat. A global workforce of millions -- highly skilled and trained -- doesn't need to be retrained. They can keep doing what they already know how to do, but this time around for clean energy.

If we're able to pull this off and team up to do it, we are talking about the ability to meet world [00:20:00] energy demand. We are talking about the ability, over the next few decades, to put more geothermal energy on the grid than we currently have in dirty energy. Geothermal energy at oil and gas scale.

So I bet I know what some of you are thinking, because I was that person, too. I used to think it. And so I will tell you how I got from there to here.

I used to feel that we just needed to let the oil and gas industry go away. So I'm a climate activist and a lifelong environmentalist, the kind that would have chained myself to a tree if I needed to, of that flavor. I grew up and got a job, became an energy lawyer and then an energy entrepreneur, and entrepreneurship took me out into the field for product deployments. And I ended up living on drill rigs. And I had a complete epiphany. It was a total mind shift, bias out the

door, because I got to [00:21:00] know many individuals in the oil and gas workforce. And, y'all, that's grit. I mean, it is incredible grit. Those people are there for it.

But I also got to know the amazing technological innovations of that industry. And what I've come to believe is those are assets -- the workforce, the technologies, they are assets that we can leverage now to solve climate change.

So what I do for my job is I recruit oil and gas veterans to the cause of geothermal. If we want to turn the ship, we recruit the sailors. And it's working.

A Messy and Unhinged Introduction to Geoengineering - vlogbrothers - Air Date 10-4-23

HANK GREEN - HOST, VLOGBROTHERS: First, let's define the term. What is geoengineering? The definition is controversial. But broadly, it's any time you take an action to intentionally change the systems of planet Earth. More specifically, these days, when we talk about geoengineering, we're almost always talking about the amount of heat.

There is other geoengineering, like if you wanted to restart an ocean current, if you wanted to change ocean acidity, if you wanted to [00:22:00] decrease the amount of storms, all those things would be geoengineering.

Now, importantly, intent does matter, because if it didn't, then the last hundred years of burning fossil fuels would all be geoengineering. We would have been engineering the planet to get warmer. But it wasn't engineered, it was accidental. We did it for other reasons, and so it's not geoengineering, it's just an oopsie. It was initially an oopsie. It's not really an oopsie anymore. Now it's, like, a stop hitting yourself kind of situation.

So, these days we're mostly talking about intentional actions taken to decrease the amount of heat in the planet Earth's system. And, importantly, there are lots of different ways to do that. We talk about geoengineering as if it is one thing. And it is not. Like, already we are doing some geoengineering. We paint roofs white? And that is like a main benefit of decreasing the air conditioning bills for those buildings, which also decreases energy consumption. But, additionally, it does reflect some amount of energy back to space. Not a measurable amount, but that's part of the reason why we do it. So, painting roofs white is geoengineering. But, heading up the ladder of complexity and impact and

[00:23:00] controversiality, here's an incomplete list of other geoengineering things:

High albedo crops, like crop plants that are more reflective and lighter colors, could make the planet more reflective.

Ocean mirrors could reflect sunlight back to space.

Marine cloud brightening would seed clouds over the ocean, reflecting more light up.

High altitude cloud thinning would thin the wispy cirrus clouds that actually do a better job of trapping heat in the system than reflecting it back to space.

And finally, stratospheric sulfur injection would mean putting a ton of sulfur dioxide into the stratosphere because those sulfur particles are good at reflecting light and they'd stay up there for a long time.

Each one of these has advantages and disadvantages. And as we went down that list, we got more impactful and scarier. Like, high albedo crops would have a small and mostly local and temporary reversible effect. Whereas, stratospheric sulfur injection would have a large and global and long-term effect.

Now, the argument in favor of doing these things, and each one of them is a solar radiation management technique. That's the term we use for managing the amount [00:24:00] of the sun's energy that gets trapped in the system. The reason why we do that is because the heat is a big part of the problem. It's not the only part of the problem, like ocean acidification would not be helped by any of these things, and that's also a big problem. But the amount of heat in the system already is making life harder on the planet, and that's just gonna keep getting worse decade by decade for a while. And honestly, we don't know exactly how much worse it's gonna get. And in fact, that is another vote in favor of doing geoengineering research. It could be that things get worse than we expect, faster than we expect, and it would be nice to have a tool in our back pocket just in case we need it, even if we don't want to use it, even if we're not sure if it's gonna work, or we don't understand all the harms it's gonna do.

The arguments against are many, and they are varied, and I have sort of different feelings about them personally. And I'm gonna give them to you as I understand them, and this is gonna be biased. First is, this is gonna be good for fossil fuel companies, because they're gonna do a lot of this work whether it's,

like, moving carbon around, or it's doing all the chemistry that's necessary to do geoengineering.

I don't care, [00:25:00] I...look, I wanna be on the record. I do not care who gets rich saving the planet. I would give the guy I hate the most in the world all of my money, if I knew for sure he could fix this problem. I would hate it. I would hate... I'm thinking of who it is. I would hate giving him all that money, but I'd do it. I might even say nice things about him afterward. Maybe. That would be harder, honestly. But, relatedly, number two, this would be good for fossil fuel companies, because we'd just keep burning fossil fuels forever if we didn't have to worry about the heat. If we could manage the heat, then we'd just keep burning. This doesn't worry me that much because I just think it's wrong. I recognize that there are people who are like this, who are like, We should just spend the money to do geoengineering and not change anything. But, ultimately, renewables are just better. I would be more worried about this if the cost of solar and wind and batteries hadn't gone by, like, a thousand times since I graduated from college. But they have! And already, in most ways, they are better than fossil fuel infrastructure, and I think 10-20 years from now, they will be way [00:26:00] better than fossil fuel infrastructure, and we just won't use fossil fuels, because they're worse.

Now, onto the things I find more compelling. Number one, this is going to be, by definition, a trolley problem. What do I mean by that? I mean that if you're trying to do something that's going to help the whole planet, there will be areas of the planet that are harmed. The scientists I've talked to are quite uncomfortable with this. They understandably do not like the idea that they might be put into a position where they'll be asked to advise on whether we should take an action that will, like, save a million lives, but actually cause the deaths of thousands of people. And this is, like, not abstract.

Now, for clarity, we already do this with accidental release of carbon dioxide all the time - not accidental, incidental. We make decisions here in America to produce carbon dioxide, and that's gonna have a negative impact on the world and it will result in death and suffering. It's not a comfortable idea, but it's a real idea. But we're not doing it on purpose. We're doing it so that we can go visit our family in Indiana. It matters when you're doing it on purpose. And part of me thinks it shouldn't matter, but it does.

So, say [00:27:00] like low level example, you just do some marine cloud brightening. You're just making it so some low level temporary clouds are over the oceans and that increases the amount of sunlight being reflected to space. But maybe the water that's forming clouds there now would have formed clouds over land and fallen as rain and you're creating a different rain pattern and those

people's crops fail. So they don't have the income they expected. They don't have the food that they expected and there's a famine. So yeah, trolley problem, uncomfortable.

Now, we do that nationally, all the time, like when we say we're gonna shut down a coal fired power plant, or we don't want as many coal fired power plants, that has negative impact on people, but we do it because it has positive impact on more people. But that's very different when that's one country making decisions for itself than if it's one country making decisions for another country, which leads me to the second thing that is a good thing to point out: actively doing geoengineering could cause war. So, say one country is taking actions that's making it better for the people in that country, but it's resulting in less rain falling or [00:28:00] flowing into another country, and that country has instability because of that. They're not gonna like each other. And that feels intentional and different in a way that having like the US and China burn a bunch of coal and then having a global impact doesn't. And I'm trying to get comfortable with the idea that the way that it feels matters. Uh, because the way that it feels matters.

Third, if we did it for a while, and then suddenly stopped, that's very scary. So, basically, if we're doing this radiation management, the amount of heat that would be in the system, if we weren't, is going up and up and up, but we're getting that heat out of the system through radiation management. If one day, through an accident, or a policy decision, or the fact that, like, one country was doing it and the other countries were like, you need to stop, if suddenly it all stopped after having done it for a while, climate models don't like that. That could result in, like, a very chaotic series of events for the planetary system. There's even a term for it. It's called termination shock. That's scary both practically and because the term. That's just a [00:29:00] scary term. That's a good one. Neal Stephenson.

Next on the list... Miriam really drove this point home to me and helped me understand it. This isn't a thing that should be done unilaterally, but it is a thing that could be done unilaterally. It's inexpensive enough to do some pretty large scale geoengineering that a single country, and not even a big one, could start doing. Also, it's totally possible that the countries doing that would be the ones who created the problems and might be doing it without regard for local impacts that would happen. So, you want to do this in a way that involves ideally all of the countries kind of coming together and reaching some sort of agreement. And in a complicated system like the Earth and a complicated idea like geoengineering, that sounds very hard, and almost like it literally couldn't happen, but maybe it could. Like, we've done diplomacy on big hard things before.

Next, and this is the second most compelling of all of these arguments to me, we actually don't understand this stuff that well yet. Miriam was talking about how, like, of all the variables in climate models, the [00:30:00] things that, like, increase the error bar the most, is actually aerosols. So, like the effect of particles in the air reflecting light back to space. That's a lot of what we're talking about in geoengineering and we don't understand yet very well the mechanism of how that works and how it much, it does what it does. And this isn't just about like energy out, energy in. If it was just energy out, energy in, then we'd understand it. But what it's also about is how it's going to affect the climate system as a whole. If we do stratospheric sulfur dioxide injection, and it decreases the temperature of the planet by a degree, that would be amazing. But what if it also dried up the monsoon season in Southeast Asia, and then hundreds of millions of people are now food insecure when they were not before? If that's a thing that might happen, you don't want to do that.

Which leads me to the last, most important thing. On the list of reasons to be very cautious about geoengineering, which is, we just got one planet, this is the only one. We're already messing with it, and that's [00:31:00] really scary, and to solve the messing with it problem by messing with it is understandably terrifying. And I'm like, okay, so we gotta understand it better, and Adam makes a great point. Which is that, in order to do an experiment that actually will tell you about the potential impacts of geoengineering, you kind of already have to be geoengineering.

Smog Cloud Silver Lining - Radiolab - Air Date 9-22-23

HANK GREEN: I had been confronted by a lot of really sort of apocalyptic ...

ARCHIVE CLIP: We are reaching the end.

HANK GREEN: ... doomsday prepper kind of people on TikTok.

ARCHIVE CLIP: Having a panic attack for the last hour.

HANK GREEN: Who were looking at the temperature of the North Atlantic Ocean.

ARCHIVE CLIP: ...unprecedented warming.

HANK GREEN: And it was hotter than it had ever been.

ARCHIVE CLIP: Ever been in recorded history. And things are only getting worse.

It's not good.

... the holocene extinction, the sixth extinction event, is probably starting now.

I'm gonna explain this with a visual aid.

LULU: And all of these TikTokers are pointing to this one chart.

SOREN: And here, I can show it to you right here.

LATIF: Oh, you just shared it to me? Okay.

SOREN: Yeah.

LATIF: Okay.

SOREN: So it's basically a graph of the sea [00:32:00] surface temperatures in the North Atlantic over the last couple decades.

LATIF: It's kind of a pretty graph, yeah.

SOREN: Yeah, it's a bunch of squiggly blue lines going up and down, and that's sort of the seasonal change. And then you can see the average is going up over time. But then ...

HANK GREEN: There's a red line, which is this here.

LULU: Mm-hmm.

HANK GREEN: And that line is creeping up, up, up. And then it has a spike.

SOREN: Sudden red, uh-oh!

HANK GREEN: Yeah, yeah.

LULU: And that line is, like, way above the average, even the seasonal ups and downs.

LATIF: It's not even close. Like, the high jumper has cleared the pole.

LULU: Yeah.

HANK GREEN: Yeah.

SOREN: And this spike is happening over the course of months or weeks, or ...?

HANK GREEN: I think it's days.

SOREN: Days? Oh!

ARCHIVE CLIP: An existential threat to everything we know.

SOREN: So all the TikTokers are basically like ...

HANK GREEN: This is it. It's happening now.

SOREN: This is us falling over the cliff.

HANK GREEN: We're falling over the cliff.

ARCHIVE CLIP: Figure out your relationship with Jesus Christ.

LULU: And are you watching this stuff literally, like, while you're getting chemo, or ...?

HANK GREEN: Yeah, I probably didn't see it, like, during the moment when the chemo was going into my body, but certainly [00:33:00] during the ...

SOREN: That does tend to be when people doom scroll.

LULU: I'm just picturing you—yeah.

HANK GREEN: [laughs] Yeah, but anyway, so I'd seen this, and ...

ARCHIVE CLIP: Are we all about to die? You may have seen this graph. If you haven't, I'm sorry ...

LULU: And Hank decides to hop on TikTok himself.

HANK GREEN: Like, I made a little series that was, like, trying to, like, contextualize it.

We're not there yet. We're not anywhere close to there.

At the time I was seeing it and I was like, I don't—like, it's probably just some kind of natural variation where it's, like, cooler than average right now in some parts of the world, and it's hotter than average in other parts. And also, we're entering an El Niño. So, an El Niño is just like a warmer climate time generally.

SOREN: And you take one little spot on the globe and blips happen.

HANK GREEN: You know, there's natural variations across the Earth.

LATIF: I don't know. That—that doesn't mean we shouldn't be worried. Like, now is not the time to say, "Hey, it's getting a lot warmer, but no big deal."

LULU: Totally. And to be clear, Hank takes this [00:34:00] stuff very seriously.

HANK GREEN: As a person who's been worried about climate change for—my dad was the state director of The Nature Conservancy in Florida when I was growing up. So, like, we're a family of environmentalists. My mom's a sociologist who worked on sustainability. Like, and I'm—like, I have a degree in environmental studies. Like, I've been in this for a long time, and it's very scary. This is, like—like, this is the biggest problem humanity has ever faced but, you know, there's sort of a debate that's like, do we need to get people more scared about climate change, or do we need to get people more hopeful about climate change? Because they can go around a bend eventually, where it's like, there's nothing to be done and I will just be hopeless and sad. And I think a lot of people are there.

LULU: Right. If you're too scared, you, like, tip into nihilism, kind of?

HANK GREEN: Yeah. And this is like, it's gonna be like a bell curve of worry that we're all on somewhere, and in order to get, like, everybody [00:35:00] to the appropriate amount of worry, we're always pushing some people to way too worried. And, like, there's like, not really too worried about climate change until and unless you give up on trying to solve the problem.

LULU: Mm-hmm.

HANK GREEN: So, like ...

LULU: So according to Hank, when it came to this temperature spike in the North Atlantic, his sense was that these people online were being way too alarmist.

HANK GREEN: There was a sort of a mathematics of gambling guy.

LULU: [laughs]

HANK GREEN: Which isn't a climate scientist. As you might expect. Who was getting traction by tweeting about how this was a really big deal, and then he was, like, getting on the news ...

LULU: Huh!

SOREN: And so Hank thought maybe this is a moment to dampen rather than, you know, fan the flames, but also keep the conversation focused on things that we might be able to do.

HANK GREEN: Over the next week or two on my TikTok, I'm gonna make some videos about the things that we are actually doing right now and will be doing in the future to help take care of this.

LULU: So that is how Hank is spending this hot, hot summer: going through chemo, holding a candle for [00:36:00] hope, battling climate nihilism. And then ...

HANK GREEN: I was scrolling science news in bed late at night, like, before going to sleep, like I do.

LULU: [laughs] Yeah.

... he comes across a link to an article that made him sit straight up in bed.

HANK GREEN: Yeah. It's like 11:00 at night. I have to get up at 7:30 in the morning, and I'm like, "Oh, I'm gonna read a lot right now." [laughs]

LULU: [laughs]

Okay, so the thing he sees, it's this article in Science, it's a write-up of three recent studies, and what they found is that the spike in the North Atlantic sea temperatures, this, like, troublingly warming water ...

LATIF: This year's spike.

SOREN: That one we were talking about, right.

LULU: This year's recent spike ...

LATIF: Yeah.

LULU: ... may have been caused by this thing, which is that a few years ago, the UN put into place some regulations that forced cargo ships to start burning cleaner fuel to, you know, reduce the pollution that they make. [00:37:00] And that, doing that good thing, these papers said, that caused the water to get warmer.

HANK GREEN: Yeah.

LATIF: Wait, so they're saying that getting rid of pollution, that you would think would make the problem better, is actually, in this one spot for a while at least, making the problem worse?

SOREN: Right.

LATIF: How?

LULU: All right, so let's go back to before this regulation, this change had happened. All these big, hulky cargo ships are criss-crossing the North Atlantic, chugging along with their big smokestacks, puffing out big plumes of smoggy smoke.

HANK GREEN: Cargo ships burn, like, the dirtiest oil. It's like the oil that's left at the bottom.

LULU: Like that mayonnaise-y black, black mayonnaise-y like ...

HANK GREEN: You have to, like, heat it up before it'll even flow kinda oil.

LULU: And so there's all this carbon dioxide going out into the air, of course, but there is also all this sulfur dioxide going into the air.

LATIF: Okay.

LULU: And that's horrible.

HANK GREEN: Sulfur dioxide is bad for people. It's like it's bad [00:38:00] to breathe, and then it is also bad for the environment because it turns into sulfuric acid when it mixes with water, and then it falls down to the Earth as acid rain. So that's where acid rain comes from.

LATIF: Hmm, right.

SOREN: Which is why the UN wanted to regulate it.

LULU: But it turns out that in addition to being horrible for human health and making acid rain, sulfur dioxide also does something else.

HANK GREEN: It actually can seed clouds. As the ship goes by and it pumps the sulfur dioxide up, you can see, just like kind of a contrail that a jet would leave behind, you can see—they're called ship tracks.

SOREN: Hank actually showed us a picture of this that was taken from space.

LULU: These tracks are like, so big. It just looks like giant zebra stripes over the ocean of just white.

HANK GREEN: When there's the right amount of heat and water in the air, you get all of these extra clouds that you normally wouldn't get.

LULU: Okay.

HANK GREEN: And the clouds reflect the energy of the sun into space. So instead of hitting the water and heating up the surface of the [00:39:00] ocean, it hits a cloud. You know, you could think of it just like a very thin umbrella. And then there's a shadow on the ocean.

SOREN: Which keeps the water at least a little bit cooler.

LULU: So suddenly you take that away, you burn cleaner fuel, and then it's like taking away the beach umbrella. You're suddenly just—you're the ocean.

LATIF: Ohh!

LULU: And the ocean is getting blasted by the sun.

LATIF: Got it.

HANK GREEN: It's not unanticipated. This is actually something that climate scientists have known about for decades. But it is non-intuitive. And what this means is that overall, we have not seen the actual full effects of the carbon dioxide.

SOREN: It's like the—the warming from carbon dioxide has been worse than you thought up to now. It's just been sort of hidden by all the dirty clouds that we've had blocking light.

LATIF: Right.

SOREN: And if you get rid of that, you're gonna realize just how bad this really is.

LATIF: Right.

HANK GREEN: Yeah, and ...

LULU: That feels like, oh, things are—this is doom-y, like, I don't ...

This now seems like a doom [00:40:00] on a doom to me, right?

LATIF: Yeah, I agree. I feel like it's a double-decker doom. Yeah.

LULU: ... just gonna burn. Like, I go more to nihilism.

HANK GREEN: I mean, I—I was—I found this very exciting and, like, fascinating.

LULU: But not to Hank Green. He reads this study and sees a silver lining, a literal silver lining in the smog cloud.

SOREN: A smog cloud that isn't there anymore.

LULU: Right.

HANK GREEN: The thing that excited me the most about it is we did it, and then we undid it in order to make life better for people who are now not

breathing that sulfur dioxide into their lungs, but now we have a chance to study what that looks like.

LULU: He sees these papers, and he's like, we have just done a pretty monumental experiment.

LATIF: Yeah?

LULU: Because for decades we had been letting these ships put out these pollute-y, smoggy smoke trails, which just so happened to act like umbrellas [00:41:00] and shade the ocean, and now that we've taken the umbrella away, we can measure how big or small that cooling effect was.

HANK GREEN: But then the broader—the broader question is can you then—if we were doing it before, and we know what the effect was, can you then find another, better way to do it intentionally without putting the acid rain stuff, smoggy stuff in the air?

How to think about solar radiation management Part 1 - Volts - Air Date 2-24-23

Kelly Wanser: I think one of the things that struck me about coming into the climate space was it wasn't very well-equipped to think in terms of portfolios. So if you look at the risk profile, it's sort of like we're having these debates about should it be wind and solar, or nuclear? Should it be emissions reductions or these things? But if you look at the risk and uncertainty involved, there's a lot of uncertainty involved in all the different ways of responding to climate change. And there's a huge amount of risk, [00:42:00] potentially existential risk. And so from a portfolio perspective, methane reduction is one of my absolute favorites. And there are some great things happening in that field. Adaptation is a harder problem, and it was made harder because people didn't want it in the portfolio 20 years ago. And they didn't want people to think it was adoptable. So they didn't want people looking at it. Well, it turns out when you look at it, you find out it's not easily adoptable, really. You can see, like, look at Pakistan. These big extreme events happen. They're pretty overwhelming. And

even in the US, we're arguably one of the best equipped places in the world to manage these things, and Austin, Texas, had, you know, a third of the city had no power.

David Roberts: Yeah, we managed to bungle it regularly, even with all our money.

Kelly Wanser: But really what it was about is saying, [00:43:00] Okay, we should have a rich portfolio here. If you thought of this as, like, shares, or you thought of this as insurance policies, we'd have a portfolio of things so that when you brought that portfolio together and those things that are different profiles and there are different levels of uncertainty, we have a lot of coverage.

David Roberts: Right.

Kelly Wanser: And the problem is that this part of the portfolio, like, if you needed to arrest climate change quickly, if you really needed to get in there and say, Uh oh, the ice sheet is about to go, the wet-bulb effects in India are happening and we can't take it, and you needed something that operated in a sub-decade time horizon, then that's the key part of the portfolio that's empty. And we don't want to do those things. But from a risk management point of view, in terms of what's at stake, even evaluating whether we have them, that's something on deck that we really should [00:44:00] be doing.

David Roberts: And one more thing about the risk question, the short-term risk question, and I feel like maybe more climate types have grown cognizant of this recently, but it's really an under-discussed aspect of all this, is the aerosol effect. So, maybe just tell us what it is and why that adds to these worries about short-term risk.

Kelly Wanser: That is a great question, because as I was digging into this and finding out the things I'm telling you, this came up. Effectively, there are forces in the atmosphere that trap heat and help keep us in this sort of temperate zone that we're in. And there are forces in the atmosphere that reflect energy away. And so the particles and clouds in the atmosphere, they're reflecting sunlight away from Earth, which is part of what keeps us in this Goldilocks zone. When you look at the Earth from space and you see that shiny blue dot, that's what that is.[00:45:00]

And these particles that come into the atmosphere, they create clouds, they live in the atmosphere. They're part of that whole system, and they come from nature, but they also live in pollution. And the particulates in pollution that

come from coal plants, that come from ships over the ocean, they are mixing with clouds that are living in the atmosphere in ways that make the atmosphere slightly brighter. And it's this effect that scientists have reported is cooling the planet currently by reflecting sunlight back to space. And they don't know exactly by how much, but they think it's between a half a degree Celsius and 1.1 degrees Celsius.

David Roberts: That's not small.

Kelly Wanser: No, it's not small. It could be offsetting half the warming that the gasses would otherwise be making.

David Roberts: Yeah. Just to sum that up. So, our particulate pollution to date has had the sort of perverse effect of reflecting [00:46:00] away a bunch of solar radiation, with the consequent problem that insofar as we clean up our pollution, which we are striving to do, we are going to lose that cooling effect and maybe get another one whole degree of warming which would double...

Kelly Wanser: That's right.

David Roberts: ...our warming since preindustrial times. So, that's a little wild.

Kelly Wanser: I was just going to say it's right there in the climate reports. And it's been there consistently, but not prominently noted, not highlighted in the sort of climate discussion. And so it's surfacing more now recently, that this was there. And we're getting very good at cleaning up pollution. One of the features of this problem is that in climate reports, when they show these effects, they'll have bar charts that show the different effects on the climate system. And they have these lines that show how much uncertainty [00:47:00] there is. This is the most uncertain thing about the climate system.

And that uncertainty has been unchanged for 20 years. We have not been able to improve our understanding of that. And so when we in SilverLining are talking about our advocacy, we're saying we need to improve our information base, we need to quickly improve our ability to do that problem. That problem happens to be the same or very similar to the problem of what if I want to achieve this effect actively. So we think it's kind of a no brainer for society to say we need to go after that problem really hard, like the human genome, and understand what's going to happen when we take the pollution away, and [ask] is there a cleaner, more controlled version of this that might help.

David Roberts: L

How to think about solar radiation management Part 2 - Volts - Air Date 2-24-23

et's just briefly touch on the main subject of your latest report, which is just research, advocating for [00:48:00] research. I come into this sort of, like, leery about doing things like this that we know so little about. But when I got into sort of reading about the kind of research we need, what's sort of remarkable is probably like two thirds of the research you're advocating is not even directly on doing these things. It's just understanding what's in the atmosphere right now, like, [asking] what are the risks of short term rapid changes now. Just very basic climate science stuff that you would think we would already be researching. I mean, I think even sort of the most committed opponent of these schemes would agree that it's crazy how little we know about this whole area of study.

David Roberts: So, maybe just talk about what, when you advocate for research, just talk about sort of the basics of what you're advocating for here. I mean, I think people will be a little bit shocked that some of this stuff doesn't already [00:49:00] exist.

Kelly Wanser: Well, thank you for that. You're exactly right because I think we were shocked, not coming from this field and just kind of looking at it as an information problem. And the problem you want to do is you want to be able to project and evaluate the risk of what the climate system is going to do. So I'd really like to be able to project with some confidence how the Earth system is going to respond to this warming over the next 30 years and then what it would look like if you change the things that are influencing it, either in the warming direction, the greenhouse gases, or in the cooling direction, what scientists call aerosols, these particles.

So, we're coming at it saying, Okay, we just want to help set us up to do that problem and evaluate what it looks like if you are introducing aerosols in different ways and how does that improve or not, like, the risk profile of what's happening. And so then we bump into [00:50:00] these gaps and what the problems that we can't do in the models and a lot of them center right in the atmosphere, that the models don't represent all the phenomenon that are happening in the atmosphere very well, and that we don't have the observations that we need to improve them.

David Roberts: It's like insane. It's like five, six decades now of talk about climate change and talk about all this, but we still on some very basic levels are just not watching what's happening in the atmosphere.

Kelly Wanser: I think people assume that it's like, Hey, we've got this, right? And you hear there are these satellites and you hear the scientific studies coming out that are projecting what climate is going to do. We have satellites looking at everything. And then you sort of dig under the hood and that's where solar radiation management just has an analysis problem. Because what some of the scientists in our circles have said is people want a higher standard of evidence for this. [00:51:00] So they're saying, well, you need to be able to tell us what will happen and what the impacts will be. And we shouldn't be having that standard of evidence for what greenhouse gas is doing and what these other aerosols are doing, but we haven't. And so we get in there and say, Okay, if you really want to do this problem, here's what you need. So, to give you [an] example, the very top candidate for this is putting particles in the stratosphere, and so if you want to project what will happen, you first need a baseline of what's in the stratosphere. And it turns out we don't have that. We can't characterize what's in the stratosphere currently. So then it's very hard to do that problem.

And so the first thing that we did when we started talking to members of Congress and working with NOAA is just to say, We have this problem of having a baseline of what's there, which is a really important problem to solve. If you want to know if somebody else is adding material to the stratosphere, if you want to know what it will do, and so that was our starting point. [00:52:00] And it's similar kinds of things now, where even in the low cogler [?] we're working on a program to put instruments on ships like the current ships that travel, that would just be taking atmospheric readings of that low atmosphere so that you would have a baseline and you'd be able to help the models and even the satellites interpret what's going on.

David Roberts: Right. So just gathering more data about what's actually in the atmosphere. So we have a baseline, because one thing the report emphasizes over and over again is that it doesn't really make sense to talk about the risk of doing these things in isolation. It's always, What is the risk of this intervention versus the risk of not doing this intervention? What are the risks we're facing as a baseline against which we are measuring the risks of this intervention? And we just don't know. That's what's wild to me. We just don't know what the current risks are. So [00:53:00] there's no way to make an informed risk judgment because you don't know the differential.

Kelly Wanser: That's right. And we haven't really invested in it, which is another quite eye-popping reality.

David Roberts: It's wild.

Kelly Wanser: Like, globally and in the United States, climate research investments have been relatively flat for decades.

David Roberts: That is wild to me. I know every time I read that - I read that statistic periodically, and every time I run across it - I'm shocked all over again. Like, all this talk, all this international action, all this agita and angst, and we're not spending any more on climate research than we were two decades ago.

Kelly Wanser: This really baffled me. Coming into this, I didn't understand it, and I sort of learned there was quite a long period of time where there was an orientation that I'm kind of sympathetic to, which was, we know what we need to know. We need to reduce emissions. And so if you think about it as like two sides of an equation, and you look at the reduced emissions side of that [00:54:00] equation, and you just focus everything on that, and you say, don't spend your energy on figuring out what's going to happen if it gets warmer, because we're not going to let it get warmer.

And really, that combined with a lot of other pressures on climate science, climate science has been in lockdown mode. I can still remember, like ten or twelve years ago. It's brutal.

David Roberts: Under siege, yes.

Kelly Wanser: Terrifying. But now we're seeing these extremes, and we've had a flat level of investment. And inside that flat level of investment in climate research, in the part that looks directly at the atmospheric observation of atmospheric basic science has actually declined in real terms.

David Roberts: Oh, my God, that is mind-boggling.

Kelly Wanser: It's heartbreaking. And that's the fulcrum for everything we need to know about what's happening and [00:55:00] how we evaluate what we're going to do. So the good thing is it represents an opportunity if we can improve it. And I'll just finish by saying climate research investments in the United States are about three and a half billion a year, and that's everything on that side of the equation. And if you compare that to the 55 billion we spent on the three most recent storms.

David Roberts: Yes.

Kelly Wanser: And even the big money that's gone into these other programs. What we're saying is, Hey, to invest an additional 60 or 70% in that bring it up to 5 and a half, 6 billion a year, that seems reasonable.

Final comments and interview with Mike Tidwell about the arguments for and against geo-engineering

JAY TOMLINSON - HOST, BEST OF THE LEFT: We've just heard clips today, starting with *PBS Terra*, giving us the current state of our best climate predictions. *Vox* looked at geothermal plants through the lens of manufacturing EV batteries. Jamie C. Beard gave a *TED Talk* in 2021 explaining her work to convert the oil and gas industry into the [00:56:00] geothermal industry. The *vlogbrothers* described some of the highlights and low lights of geoengineering. *Volts* in two parts looks at the prospects of studying geoengineering, solar, radiation management to stave off climate impacts. And *Radiolab* told the story of some of the accidental geoengineering we've already been doing with the sulfur dioxide coming from cargo ships.

Now to finish up, I want to introduce you to Mike Tidwell, to talk through a few more concerns about geoengineering.

Mike has been a climate activist for around 20 years and runs the Chesapeake Climate Action Network. He has done a lot of good work in that time, but he's also made the questionable decision to hire me way back in 2007. So, his record is definitely not spotless. And it was from Mike either that year he hired me or the next year, 2008, that I first heard about the concept of geoengineering. So, he's clearly been thinking about this for a long time, which is why I had him in the back of my mind as we were making this [00:57:00] episode and why I wanted to get his personal take on some of the arguments and counter arguments for and against doing geoengineering research or even possibly implementing those ideas.

Spoiler alert. He is in favor of studying it. So I just wanted to ask him to explain his reasoning. He started by describing the sense of urgency we need to feel about all potential climate solutions.

MIKE TIDWELL: The major things that I have tried to pay attention to over the last 20 years as a climate activist is, number one, how fast are we making

the switch to clean energy? The good news is we're making that switch. substantially, we really are, especially culminating with the passage of the Inflation Reduction Act of 2022. We're going to see up to 1. 7 trillion dollars in clean energy investments over the next decade. It's just amazing. The problem is we waited too long to get there. As Bill McKibben [00:58:00] says, winning slowly is the same as losing. So we're winning, and that's encouraging. But with each passing year, especially in the last five years, the news on accelerating climate impacts, the degree of warmth, the rise of sea levels, et cetera, has become startling and it's clear that the science is telling us we've waited too long to begin to make the transition to clean energy.

So if we've waited too long, therefore what? All the things that we're seeing now across the planet, James Hansen has predicted, and now he is saying our most accurate prophet of climate change, James Hansen, our top climate scientist, formerly at the NASA Goddard Institute for Space Studies, Dr. James Hansen has been saying the last few years and really shouting it from the rooftops this year that we have to not only switch to clean energy as fast as we can, [00:59:00] not only do we need to try to sequester carbon and suck carbon out of the atmosphere as fast as we can, but we also have to reflect sunlight away from the planet, or at least we need to really study it, in detail, with billions of dollars put into experimentation and research to at least rule out the truly crazy stuff and focus on the stuff that we have a high confidence level will A) cool the planet and B) do so with the least amount of negative consequences as best we can tell.

I don't know if it's inevitable that we're going to do this. I'm not saying with complete certainty that I know we need to do this. What I believe and I think what Dr. James Hansen and hundreds of his colleagues who signed a letter to this effect in February of 2023 are saying is we need to at least study it and have that emergency [01:00:00] option available to us, because the trends are depressing now, and the warming is accelerating beyond most predictions now, 2023 being about to become the warmest year by far in the history of the planet going back at least 125,000 years, blowing 2016, the last record year, out of the water. It is now time for us to begin seriously studying and considering a plan B that involves reflecting sunlight.

JAY TOMLINSON - HOST, BEST OF THE LEFT: And a quick note for the members. These next two questions will be for members only. So if you're hearing this, thank you for your support and enjoy this extended bit of the interview.

The first specific argument that I asked Mike about was the most philosophical of all the arguments against geoengineering. That being that the type of

dominionist thinking that humans sort of control nature, and we get to do whatever we want with it. That's the sort of thinking that got us into this mess in the first place[01:01:00] and that it is that same well of thought from which the idea of geoengineering has been drawn. And so to get nature back into balance, humans need to adjust to the demands of nature, not try to manipulate it further.

MIKE TIDWELL: I think it's a valid consideration, except for one central problem, and that problem is, nature is over. As Bill McKibben wrote in 1989 in his seminal book, *The End of Nature,* there is nothing natural on the planet anymore. When you change the atmosphere, you change every square centimeter of weather conditions all over the world. So, listening to nature, yielding to nature, following nature on this planet as a solution to our problem is not possible.

One thing that we have done over the last 300 years of the [01:02:00] Industrial Revolution and the beginning of the rapid warming of the planet through our use of fossil fuels, we have not only simultaneously warmed the planet, we've also created cooling, which is a strange concept to hold at the same time. We've been warming and cooling the planet at the same time. The aggregate trend toward more warming, but by burning fossil fuels, especially coal, we also inject sulfur dioxide into the atmosphere, and that sulfur reflects sunlight. So, we've been masking the full severity of the warming. We've already been geoengineering the planet for 300 years. We've been inadvertently engineering the planet toward warming overall and now the idea is we could advertently *[sic]* engineer the planet toward more cooling for at least the next several decades while we complete the [01:03:00] transition off of fossil fuels.

JAY TOMLINSON - HOST, BEST OF THE LEFT: I also asked about the divide in thinking within the community of climate scientists. Many are on board with studying geoengineering, even if they currently oppose implementing it. But there are others who believe it's a false and unnecessary solution. So, how should we nonscientists know who to trust?

MIKE TIDWELL: James Hansen has argued that the IPCC has consistently been too conservative in its projections of coming warming. They've been too conservative in their confidence that clean energy can make the switch in time to stabilize the climate. And part of that criticism that Hansen has of the IPCC right now is that the IPCC is saying to stabilize the climate in the next century, we have to suck unbelievable amounts of carbon out of the atmosphere. [01:04:00] We have to draw down so much carbon, like a hundred gigatons per year by 2100, which by the way, is like three times more CO2 than we're putting into the atmosphere last year. So the idea that we're going to successfully draw all this carbon out of the atmosphere is increasingly becoming unlikely.

There are academics who call this "carbon unicorns". We can't plant enough trees. We can't build enough machines that can suck the CO2 out of the air. Carbon direct capture, today, that technology, is where solar energy was in the 1970s. I mean, we are way behind. So Hansen says, look, we're not making the switch to clean energy fast enough. We don't have the technology to withdraw CO2 from the atmosphere fast enough and both of those trends implicate the IPCC as [01:05:00] being too conservative, too optimistic in their predictions. And if that's the case, then we need to consider reflecting sunlight away from the planet. And that's where I see things. I come to this not as a scientist, not as a techno... Silicon Valley technology is going to solve all our problems. I come to it as a climate activist, someone who's paid serious attention to the progress of the transition to clean energy, who's paid a lot of attention to the science, multiple camps of the science, but who now in 2023 rely on James Hansen as the proven most reliable voice in what should come next in our climate movement and what he's pointing to. Is we need to study this issue of solar geoengineering reflecting sunlight away from the planet to have any hope of stabilizing the climate

JAY TOMLINSON - HOST, BEST OF THE LEFT: I [01:06:00] then asked about one of the major arguments against geoengineering, which is that it could potentially sap the motivation for society to continue to decarbonize our energy infrastructure. Like, well, if we're doing this and it's making climate change a better than, I guess we don't need to actually reduce our emissions as much. Right?

MIKE TIDWELL: There are those who are afraid that if you go down the path of trying to reflect sunlight away from the planet, you create a so-called moral hazard that you create the circumstance where by taking that action, by using sulfur dioxide to reflect sunlight from the planet... and you're talking about just reducing between one and two degrees the amount of sunlight coming into the planet. This is not a radical reduction. Volcanoes have done it in the past. But the idea is if you start doing that, then why stop burning fossil fuels? You'll just create an excuse to keep burning fossil fuels. That's the so called moral hazard of solar geoengineering.

There [01:07:00] are several things to consider here. One is that same argument can be applied to sequestering carbon, to direct carbon capture, to trying to suck carbon out of the atmosphere. That, too, could have a moral hazard. I mean, why get off fossil fuels if you could just burn the coal, send the CO2 to the atmosphere, and then suck the CO2 out of the sky and bury it under the earth. So, this issue of moral hazard applies to things that the IPCC has already embraced, i. e. carbon capture. But the biggest issue here is that there is no stopping the clean energy revolution. I mean, it's happening. We are winning too

slowly, but we are winning. The transition is happening. I mean, when California and the European Union all declare that by 2035, they are not going to permit the sale of [01:08:00] internal combustion engine cars in their jurisdictions, that's going to influence the whole world. I don't know why anyone would buy stock in ExxonMobil when it is certain that the cars that that oil would power aren't going to exist much longer by statute in much of the world. And that's just cars. I mean, look at the progress we're making in solar, the prices, I mean, utility scale solar with battery storage is the cheapest form of energy in the history of energy. And it's here today being deployed. There is no stopping that. That genie is out of the bottle.

So I'm not concerned about the moral hazard when it comes to solar radiation management. I'm not concerned that it's going to stop the clean energy revolution. It cannot. And then there are additional arguments for why even if you can cool the planet artificially why you should not continue to [01:09:00] burn fossil fuels because it is acidifying the oceans. We have ocean acidification that could take down human civilization on its own. So, there are many arguments to get off fossil fuels.

JAY TOMLINSON - HOST, BEST OF THE LEFT: Next up is the rogue nation concern. It was said during the show, solar radiation management "isn't a thing that should be done unilaterally, but it is a thing that could be done unilaterally". And so there's this fear that just studying it could help boost to the associated engineering to help make it happen and then even if all the scientists are super cautious and advise against anyone doing anything rash, their work could be used by desperate people, likely those being most adversely affected by climate impact, or maybe some corporation with the idea that this is the way to go and so they're just going to take it upon themselves to do it. Anyway, that someone might act unilaterally using the scientists' research, which would be dangerous for us all. So, maybe it's too dangerous to [01:10:00] even study.

MIKE TIDWELL: The other issue that people bring up when it comes to reflecting sunlight from the planet is that if you start to study it, then you create enough knowledge for rogue nations, perhaps prior to some international agreement to do this in an orderly, reasonable way, some rogue nation that's under particular climate stress might obtain that science and technology and do it on their own in an act of desperation. And I would argue that rogue nations can do that today, because, honestly, the blunt technology needed to try to cool the planet already exists.

I mean, you could use artillery, you know, high elevation artillery shells to send sulfur dioxide into the lower stratosphere now. You could use converted aircraft to do the same. Individual countries can do it today. China could do it. The

United States could do it. [01:11:00] Brazil could do it. And it won't be long before you know, some coalition of Pacific Island nation states could probably do it.

So, It's because it's so easy now that we really ought to study it and rule out the really crazy technology and try to settle on what might be the highest probability success technology. Spend 10 years really bringing the smartest people together, not saying this is inevitable, not saying we're definitely going to do it, but saying it looks like this sure might be necessary, let's really study it carefully, let's have an international agreement that no one's going to use this technology until this international academy makes its recommendations by some fixed future date and then let's try to enforce those rules.

So, I think the rogue nation fear is already here, and if you want to reduce the likelihood [01:12:00] that a nation could go rogue on this, you're better off studying it as an international community and trying to come up with international rules for its use

JAY TOMLINSON - HOST, BEST OF THE LEFT: And finally I asked about one of the stickiest problems, which is the need for international cooperation and good governance over the course of several decades to properly manage solar radiation through geoengineering with the risk of termination shock, which we heard described in the show, if we can't keep things running smoothly. And no one listening right now needs to be reminded that both national and international politics is a bit on the chaotic side right now.

MIKE TIDWELL: Maintaining global political stability is certainly a challenge right now in 2023, no doubt. And those who argue that it is nearly impossible to conceive of an orderly international body and decision making process to govern the reflection of sunlight away from the planet is a [01:13:00] reasonable concern for sure. However, we have to do difficult things in this century. We have to overcome amazing obstacles. We have to deal with the warming and the politics at the same time and to give up on either one of those to say, Oh, there's too much warming. There's no hope. Let's just burn coal and forget about it and take what may come, that's absurd. To point to political instability and the rise of fascism and all the other issues that we see in the world, including multiple wars and therefore throw up our hands and say, we can't ever have a stable political system sufficient to save ourselves from runaway warming, is also absurd. We're going to have to try to accomplish these difficult things. And I would just, speaking of the politics, you know, the Biden administration's Office of Science and Technology put out guidelines in June [01:14:00] of 2023 for the possible study and experimentation of solar radiation modification, reflecting sunlight from the planet. They don't embrace it. They

don't say it has to happen. But what they put out were guidelines to say, if we study this, if we experiment with this, these are some of the considerations and guidelines that scientists and politicians should adhere to. And you can find that online, it's readily available, it came out in late June of this year.

What I took away from that report was an approach that they called risk versus risk management when considering whether to study and possibly deploy solar radiation modification techniques. And what they basically say is that attempting as a international community through science to reflect sunlight away from the planet to therefore [01:15:00] relieve global warming while we get off of clean energy is terrifying and it is risky. Yes, it is risky. There are risks involved. But what they ask is, is it risky compared to what? And "the what" is runaway climate change, the kind of unbelievable warmth that we've seen in 2023 times three or four or five orders of magnitude down the road, which means synchronized global bread basket collapse, you know? Agricultural problems, sea level rise in the meters, not in the feet, et cetera, et cetera. We have to compare the risk of studying and potentially deploying solar geoengineering versus the risk of not doing it. And I think it's a study worth engaging in. I think it's a conversation worth having. And the risk also applies to our politics. Is it risky to try to [01:16:00] assume that we can bring the world's countries together to try to have a decision-making process on solar radiation modification? Is that risky? Yes, of course it is. Is it going to be fraught with problems? Of course it will be. But compared to what? Compared to not trying and not talking and not trying to appeal to our mutual common interests, to not bringing China and the United States together to really consider all possibilities to preserve agriculture?

I think that we can't just see reflecting sunlight is some inherently dangerous scenario without considering not doing it. And I think that's what the Biden administration has said in their report, and it's a conversation we need to have, and if we're going to believe James Hansen, who's been right on these climate issues and the major crossroads and forks in the road over the last several decades, James Hansen has been correct [01:17:00] in his predictions, his diagnoses on the problem, and I think he's correct today in saying the world's governments must begin studying this issue of how to reflect sunlight away from the planet and must be prepared to hold it as a plan B in case it becomes necessary

JAY TOMLINSON - HOST, BEST OF THE LEFT: Thanks to Mike for taking some of his very minimal free time that he was spending with his family on a holiday weekend to talk us through all of that. And now I'll just finish with this thought about the debate, not over deploying a geoengineering strategy, but just over studying it.

I had this thought before talking with Mike, and then he echoed the same sentiment, which is that solar radiation management through sulfur dioxide in the stratosphere is so easy and cheap that it doesn't seem likely that a desperate rogue nation would need for research to go any further than it already has for them to think that they should give it a try. In fact, a [01:18:00] geoengineering startup company in January of this year already started launching weather balloons to deploy sulfur dioxide. So, the fear that doing more research may open the door for rogue entities is a classic case of closing the barn door after the horse has already bolted. So, given that, I find it hard to take any arguments against further research very seriously. Because the best case scenario is that we do a bunch of research, learn a lot of great stuff, some of which will almost certainly be useful in ways we can't foresee, and then we'll never have to actually implement geoengineering of any kind because maybe we'll have figured out scalable geothermal energy so that we begin to decarbonize faster than anyone dared hope.

But failing that, by having done the research we'll have given future generations one more tool in their tool belt that they can choose to use or not. As [01:19:00] James Hansen, who we just heard a lot about said, "We have no right to ban the right to search for a solution for the mess we created". And so I absolutely believe that everyone has the right to withhold judgment on whether or not we should ever implement a geoengineering strategy. But doing the research to learn more about it. I can't help it come down on the side of saying yes, we need to learn more.

That is going to be at for today. As always keep the comments coming in. I would love to hear your thoughts or questions about this or anything else. You can leave us a voicemail or send a text to 202-999-3991 or simply email me to jay@bestoftheleft.com. Thanks to everyone for listening. Thanks to Deon Clark and Erin Clayton for their research work for the show and participation in our bonus episodes. Thanks to our Transcriptionist Trio, Ken Brian, and LaWendy, for their volunteer work helping put our transcripts together. Thanks to Amanda Hoffman for all of [01:20:00] her work on our social media outlets, activism segments, graphic designing, web mastering, and bonus show co-hosting. And thanks to those who already support the show by becoming a member or purchasing gift memberships at bestoftheleft.com/support you can join them by signing up today, and it would be greatly appreciated. You'll find that link in the show notes, along with a link to join our Discord community, where you can continue the discussion.

So, coming to from far outside the conventional wisdom of Washington, DC, my name is Jay, and this has been the *Best of the Left* podcast coming to you

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