00:14

What is causing climate change? I mean, it’s greenhouse gas emissions from human activities, of course. But which human activities? Who specifically is burning all of these fossil fuels, and for what and where?

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It sounded strange when I first heard it, but I have come to learn that even today in the 21st century, scientists have surprisingly little information about this question.

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So I'm part of a new coalition of scientists, activists, and actually tech companies working to address this issue. It's been a stranger journey than I expected. Let me break it down for you.

00:47

So we've known for decades that emissions are rising in the atmosphere because we can see them swirling up around there. So the famous Keeling Curve is based on what we can actually see from space. But what you can't easily see from space is how did they get there? It still boggles my mind, but even in the year 2021, in most countries and most sectors of the economy, our process for actually answering where are all those emissions coming from is still to ask polluters how much they polluted. Just kind of like hope nothing is missing in that inventory and then add up all those numbers, sometimes manually, on paper. It's amazing that every single country in the world has agreed to this process. It's one of the great things that brings me hope that everyone in the world is essentially contributing to this process. But it is such a stopgap solution. If we're really serious about stopping climate change, you can only manage what you can measure, and we need to have more information. We need to have information, not like letting it take years to compile manual reports. I mean, there are countries that haven't had an emissions inventory in 20 years. What are you actually supposed to do with information that old? We need to not just be looking at what are the emissions of entire countries, because if you want to know how to reduce them, you need to know: Do I need to go after cars or factories? What in my country is driving all these emissions? We can't keep relying on asking polluters to report how much they polluted.

02:12

And there's even more subtle problems. Like, one that really gets me is if one company reports it's reduced its emissions, we don't have a good way to know right now is that a real reduction, should we celebrate, or did they just play hot potato and sell something that pollutes to another company? If we want to get really serious about fighting climate change, we need better tools.

We need to have some way to get information in ideally real-time, not years later; that doesn't rely on just asking the polluters; that has really detailed information about where those emissions came from, not just country level; that is open and transparent, so everybody knows they can trust it; and ideally, that's free, because we can't just have a situation where only those who can afford to pay know how much is being emitted.

02:52

So that's a serious scientific and engineering challenge. How exactly would you go about building a system like that? Well, you might want to start with a photo like this. We know, because this is one of the few power plants in the world that actually has a CO2 emissions sensor in its stack that at the time this photo was taken, it was emitting 2,930 tons of CO2 per hour. But we also know that a short time later, the same exact power plant looked like this. And at that time, of course, it was emitting zero tons of CO2. I mean, you can see that with the unaided human eye. But often, it's a little more complicated. And so we have started to work as a cluster of small NGOs on training computer vision AI algorithms to look at hundreds of thousands of photos like this to recognize what a power plant looks like when it's polluting a certain amount of pollution from space.

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The reason we can do this is that there are so many free and public satellite images available now from sources like NASA's Landsat 8 or China's Gaofen 6. It's possible actually to get photos every few days of every major power plant in the entire world.

04:00

And so my organization, WattTime, and a number of other small NGOs have teamed up to build an artificial intelligence algorithm that can scan visual imagery like this every few days and look, without asking the polluters, to see how much they are polluting for every power plant in the world. It's pretty exciting.

04:17

(Applause)

04:21

You can actually do better than that. Because there are other forms of satellites as well. Just like in the movies, we can switch to thermal infrared and we can look at whether power plants are hot

as well. That matters because that's a completely independent assessment with different satellites and different techniques. So if those two methods agree, that's really encouraging. We found the right answer. You can also look at information like: Downwind from a power plant a little while later, do we see more emissions in the atmosphere where they ought to be? You can even do really subtle things, like you can look at the cooling water intake valve near a power plant. Using commercial imagery from Planet, we are able to see ripples in a river near a power plant. And that means it's drawing in so much water because it's that hot and polluting.

05:01

So no one of these techniques is perfect, but it's pretty remarkable how accurate they start to get when you combine many, many different independent techniques. We got pretty excited when we were starting to get pretty good results measuring all the power plants in the world. But then Al Gore, amazing as he is, encouraged us to dream bigger. And so we got the challenge from him and the partners of Generation to not just think small in terms of power plant emissions, but to see if we could do all human emissions from all major sources in the planet and make that available and free to everyone. And with their support and with a whole lot of teaming up with other organizations, collectively, all of us have been able to do just that. So --

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(Applause)

05:45

A really exciting example of this is Transition Zero. So they're a UK-based organization that is able to monitor the emissions of steel mills, and they can do that even when those emissions are invisible to the naked eye. Because one of the really important, interesting things about artificial intelligence is with different forms of signals from satellites, we can look at very specific chemical processes in different parts of the supply chain. You also have the ability to measure factory farms. Did you know even the United States EPA in charge of regulating them does not have a complete inventory of how many highly polluting factory farms are in the United States? But a start-up named Synthetic has been able to apply computer vision to build an inventory of them and is now scaling it up to expose every factory farm worldwide. RMI is monitoring oil and gas emissions from production and refining. Blue Sky Analytics, based in India, is monitoring crop fires and forest fires. You want to talk about car transportation? Johns Hopkins University is modeling all the ground transportation and looking at the road networks worldwide.

06:41

Each one of our organizations has learned to specialize in one or two forms of particular emissions. But we're sharing them all in a giant database known as Climate TRACE. One of the interesting things about Climate TRACE is that it's fundamentally built on global techniques. So here you're looking from Ocean Mine's model of every single ship on the planet and the associated emissions.

07:02

This is really powerful because it used to be the case that only rich countries can afford to look at their emissions in great detail. We are talking about properly global systems that are available and free for everyone.

07:13

The reason, of course, we can do this is because satellites have come down so much in cost. There are now literally thousands of eyes in the sky up above us, and many of them are actually free and open to anyone to use that information. But you know what's come down in recent years even more in cost than satellites? Big data and AI. I mean, we now live in a world where if a certain meme is trending on Twitter, there are automated marketing algorithms that know that worldwide in minutes. We suspect there are stock market algorithms that know it in seconds; it's really useful for day traders. So we actually exist as a society spending more resources on monitoring funny cat video views on the internet than a civilization-threatening crisis.

07:50

(Laughter)

07:51

Something just seems strange about that. And so at Climate TRACE, we decided to take a tiny, tiny fraction of those resources and those technical monitoring capabilities and reallocate them to actually monitoring emissions. So it's this giant shared database. I mean, we have software engineers volunteering their time on nights and weekends to make the data engineering work. We have academics validating algorithms. We have NGOs running different models. We have sensor and satellite data companies donating code. And much like Wikipedia, what's going on is all of these many, many different experts are sharing our resources in a single common pot that anyone can see, everything has to be cross-validated, and it's available to the public. The biggest difference from Wikipedia is there's a lot more real-time sensors involved.

08:34

So why are we doing this? In a word, transparency. We were approached early in the project by a former climate negotiator who told us that the heart of the Paris Agreement is supposed to be that countries are able to see what everybody else is doing. They can learn to trust each other, and that's why they're willing to hold hands and leap together. But the problem is, there's a lot of self-reporting going on, and a lot of countries don't have the resources to do this very expensive old form of monitoring. And so what we've tried to prioritize for Climate TRACE version one is releasing before COP26, last month, September 21, a version of Climate TRACE that is free and available to everybody, that has the emissions for every country, every sector and every year on the planet. So here we're looking, for example, at the emissions of rice production in Malaysia in 2020. Or Australia's electricity emissions in the same year. This is all available to anyone on climatetrace.org for free.

09:24

Thank you.

09:25

(Applause)

09:30

Now it is imperfect. Artificial intelligence starts out not quite as good, and it gets better over time. So far, one of the things we've been able to measure is: What does this compare to what countries have been reporting? So we can't say that our methods are completely perfect yet, but one of the big questions we get is: Should countries trust each other? And one of the most surprising things I think I've learned from this project is that I think the answer is yes.

09:54

I mean, we've definitely found some missing emissions. There's a few industries that we need to go have some hard conversations with. But by and large, what we've been really struck by is the vast majority of countries appear to have been able to get away with murder, but negotiating with each other in complete good faith. If you're a climate negotiator heading to COP26, I would like to just pause and appreciate what that implies for trust in what's about to happen.

10:16

But I think it'd be a waste of AI if we stopped there. So our next step for Climate TRACE version two, what we're working on, is making every single emitting asset in the world visible. So it's going to look like this. And what that's going to mean is not just national totals, but giving tools. I've spoken with governments that are interested in knowing: Where in our economies are the emissions coming from? I've spoken with companies who'd like to green their supply chains, but they have to know which factories are cleaner than which other factories. I've spoken with asset managers who are investing 43 trillion dollars in net-zero, but to actually achieve their goals, they need a way to manage and measure: Are those emissions reductions really happening?

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So I think it's pretty exciting that we can now ensure that if anybody in the world is trying to hide emissions, they can just forget about it. Those days are over.

11:01

(Applause)

11:06

Thank you.

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But the part that really excites me the most is giving tools to others in the climate fight to get the job done faster.

11:15

Thank you.

11:16

(Applause)