Host: Robert Frederick
Hello and welcome to The Conjectural — an experiment to figure out a better way to decide what science news is and how we should talk about science. The data for this experiment? Your feedback to TheConjectural.com. I'm Robert Frederick. In this episode, a story about the world's largest rainforest and how scientists don't really know what will happen to it with a warming climate.

In 2005, the Amazon forest experienced a terrible drought. Many crops failed. Whole lakes evaporated. It killed off a lot of fish. Disease spread. It stranded boats and the people who used them. There was economic havoc.

Interviewee: Scott Denning
When the 2005 event happened there was a lot of scientific interest in it. And people published papers saying this is likely a hundred-year event.

Host: Robert Frederick
Scott Denning is a professor of atmospheric science at Colorado State University.

Interviewee: Scott Denning
And then it happened again five years later, and it was like 'Well, maybe it wasn't a hundred-year event.' Certainly not anymore, right? So that's the problem is that the climate is changing, and what used to be very rare droughts in a rainforest have become more common already. And the question is 'Well, how bad does this have to get before we wind up killing off the trees?' And that's the question I would like to try to answer.

Host: Robert Frederick
The reason that question matters is because there's been a fair amount of work among climate scientists about what the tipping points are — the points at which the accumulation of all the little changes we've seen so far to Earth's climate cause big changes to Earth's climate. One of those potential tipping points is that as the tropics warm, causing more water to evaporate out of the forests, the tropical forests become unsustainable. They can't get enough water. The trees die.

Interviewee: Scott Denning
If that happens, all of the carbon that is currently trees and leaves and, you know, dead branches and stuff on the ground turns back into CO_2 through rotting — decomposition, which would be terrible because it would accelerate climate change and is sort of a runaway process. Not that it would runaway and become like Venus or something, but that it might amplify the amount of warming that we got from just the fossil fuel CO_2.

Host: Robert Frederick
And some climate models show the Amazon forest dying off as the climate warms.

Interviewee: Scott Denning
And other climate models don't do that. They get hot, but they don't kill off the rainforests. So there's a lot of question about why and how does the real world work as opposed to the model worlds.

Host: Robert Frederick
Of course, the model worlds are educated guesses — hypotheses — of how the real world will work in the future. But Denning doesn't want anyone to think that global warming is some kind of theory based on computer models.

Interviewee: Scott Denning
Global warming is based on common sense.

Host: Robert Frederick
That's Denning speaking at the Sixth International Conference on Climate Change, hosted by The Heartland Institute back in 2011.

Interviewee: Scott Denning
It's not based on computer models. It's not based on recent temperatures. And it's not complicated. You're plenty smart enough to understand it with your own brains. You don't need experts. It's all about heat. Heat in. Heat out. That's really the whole story. You know this to be true. In your own experience, you know that the more heat you put in, the warmer it gets. The more heat that goes out, the colder it gets. When we talk about weather, we have to talk about heat coming in and out the sides. But we talk about the whole planet there are no sides. The heat can only get in and out the top.

Host: Robert Frederick
Denning says he really enjoys giving these kinds of presentations to climate-science denying organizations, like the Heartland Institute, which is headquartered in Chicago.

Interviewee: Scott Denning
It's fun because it's unexpected for them to have a climate scientist come in and talk to them about heat in minus heat out equals change in heat, you know, basic fifth grade level understanding of the climate system. They're expecting to have somebody give them a bunch of indecipherable graphs, computer model predictions, doom and gloom. There's sort of a cliche that they expect me to fulfill, and it's entertaining to me to sort of bust their bubble and turn out to be funny and telling jokes and self-deprecating and by the way, hopeful about the future.

Host: Robert Frederick
How hopeful? Denning thinks we can solve the climate problem.

Interviewee: Scott Denning
Don't think it's the end of the world. I don't think humanity is screwed. I think this can be a solved thing, and I like to turn it around to audiences like the Heartland Institute and say, "Are you trying to tell me that in the greatest country on Earth with, you know, the free market, that our people are too dumb to solve this? That our engineers are incapable of rising to this challenge, you know?"

Host: Robert Frederick
Again here's Denning in 2011.

Interviewee: Scott Denning
Physics basically doesn't care what you believe. People will wind up adapting to this. They always have. They always will. But if you don't help us to figure out how to adapt, we're going to wind up adapting in ways that are unacceptable to you.

Host: Robert Frederick
…with policy already being enacted to deal with the perceived needs for addressing climate change. So, to better understand what those needs actually may be, Denning applied for and received a grant from the U.S. Department of Energy to study the Amazon rainforest in order to make climate models better.

Interviewee: Scott Denning
So we're just starting this new study to look at drought in the Amazon at different spatial scales and different time scales.

Host: Robert Frederick
In other words, Denning wants higher resolution. Right now, he says, most climate models consider the Amazon region as if it were divided up into chunks the size of the state of Connecticut. So that means the rainfall from a heavy thunderstorm, for example, is interpreted by some of these climate models as if it were a drizzle, because the rain from the heavy thunderstorm is spread out over a large area. Now the water from a drizzle would barely reach the ground in the Amazon because of all the leaves in the dense canopy, so more of the water — sitting on the leaves — would evaporate back into the atmosphere rather than get to the ground and into the roots of the trees. Thunderstorms do happen in the Amazon, so getting a higher resolution of rainfall data helps in better understanding what's going on — in the trees, on the leaves, and in the clouds, because of course, water vapor is a greenhouse gas.

Interviewee: Scott Denning
Many parts of the Amazon, I mean you think of it as incredibly wet all the time, and that's true in some areas, but, I don't know if you ever sort of look at a map of that, but in the northwest Amazon it's very wet almost all the time, and as you go south and east across the Amazon — over thousands of miles — you get into more and more of what we call it a "dry season." There's a wet season and a dry season. And in the dry season it still rains but it rains way less. And those dry seasons get longer and longer and longer as you go south and east until the dry seasons are too long and there's no more trees. So, oh, that's interesting. Maybe that's kind of an analog for the future: are we going to start having longer dry seasons? So can I understand the effect of those longer dry seasons on different forests along that transect from the northwest to southeast?

Host: Robert Frederick
So the data Denning is gathering for his study comes from four sources: looking at these northwest-southeast changes in rainfall but with higher resolution, the records from the droughts of 2005 and 2010, an experiment that actually causes persistent drought in a tiny region of the Amazon, and some satellite data.

Interviewee: Scott Denning
We've got a couple of experimental plots where colleagues built enormous gutters in the forest over areas of like five acres that they tried to capture rain before it got to the ground and then channel it out of the forest and measure — over a period of five years — the changes in that forest as it slid into very long-term, horrific drought.

Host: Robert Frederick
And the satellite data?

Interviewee: Scott Denning
There's a new satellite technology that actually — so most of the time when we measure forests from space, we're using reflected sunlight: the sun hits the trees, reflects in different wavelengths — different colors — and we can sort of measure that at the top of the atmosphere. But a lot of times it's really hard to use in the Amazon because it's cloudy. Turns out there's a tiny tiny bit of light that comes up from the forest that is not reflected from the Sun. Way down at the molecular level inside the chloroplasts of plant leaves, there are chlorophyll molecules that fluoresce, fluoresce like florescent light. They glow. They emit photons of very specific wavelengths that are not present in sunlight. And we can detect those photons above the clouds — through the clouds — those photons make it through the clouds. I can measure the amount of photosynthesis in different places in the Amazon through the clouds over a period of time. And between all four of those things — so, north-south gradients, the bad droughts in the last ten years, the persistent drought experiments with the gutters, and then this new satellite technique with florescence — we're trying to answer the question 'How vulnerable are those ecosystems to drought on seasonal to long-term timescales?'

Host: Robert Frederick
So what's the timing for the results of the study?

Interviewee: Scott Denning
I guess I have a final report that'll be due by the middle of 2018….

Host: Robert Frederick
And how do you think it's going to go?

Interviewee: Scott Denning
I think we will have a much better idea of of how sensitive those forests are to drought, and whether leading climate models get that right. We'll see how it goes. I don't know how it's going to go.

Host: Robert Frederick
You've been listening to The Conjectural. Thanks to Scott Denning of Colorado State University. Find us online at TheConjectural.com where you can give feedback and support that makes this show happen, download a transcript, and subscribe to the show. Follow me on Twitter @TheConjectural. I'm Robert Frederick. Thanks for joining us!