In These Times, Season 3 | Climate Change and the Problem with Time (Episode 7)

Alex Schein:

The vastness of scientific information can cause us to look up at the stars with awe, but can also cause other reactions like skepticism and disbelief, denial, and discomfort, and even fear. On this season of the OMNIA Podcast, we talk to scientists and other scholars about scientific ideas that cause big reactions. We'll look at stories of science getting knocked around and standing back up again in a world full of polarization, politics, misrepresentation and simple misunderstanding. Welcome to In These Times, Fear and Loathing and Science.

Our final episode is about climate change. It's come up a lot this season. It's been in the news too as the 2021 United Nations Climate Change Conference in Glasgow made headlines around the world.

Speaker 2:

World leaders are in Glasgow for that historic climate summit, COP26. It's been billed by many as the last best chance to save humanity.

Boris Johnson:

It's one minute to midnight on that doomsday clock and we need to act now. If we don't get serious about climate change today, it will be too late for our children to do so tomorrow.

Alex Schein:

The conference highlighted the urgent need to limit the planet's warming to 1.5 degrees Celsius or 2.7 degrees Fahrenheit by 2100. If temperatures get any higher, scientists predict dire consequences, including the increase of storms, floods and other weather events once thought rare. Our planet is 4.6 billion years old. It's been through a lot of changes in that time from ice ages to periods of extreme heat. The scale of those changes is sometimes hard to grasp. It's also hard to truly understand what our world may look like in the future, and how our actions now have far reaching impacts. Welcome to episode seven, Climate Change, and the Problem with Time. To get started, let's talk about how we know what we know.

Irina Marinov is an associate professor in the department of Earth and environmental science at Penn. She is an oceanographer and a climate modeler.

Irina Marinov:

I grew up in Eastern Europe, in Romania. And I noticed early on the environmental destruction that the collapse of communist industry brought with it. I somehow always knew that I wanted to save the planet. And science was a natural fit to me. So I arrived at physics as a first step. And then later on, in graduate school, I went to climate sciences.

Alex Schein:

Professor Marinov is an expert in climate modeling. Climate models allow scientists to make predictions about how lands and oceans will be affected by things like rising temperatures and carbon output.

Irina Marinov:

Climate models. How do climate models work? Climate models also known in our jargon as general circulation models or GCMs use mathematical equations to characterize how energy, water and gases such as CO_2, for example, interact in different parts of the ocean atmosphere and land. We use these equations to represent well documented processes, physical and chemical processes, for example, conservation of energy and conservation of mass, but also how water, wind nutrients and gases move with air and water currents. We have equations in these models, not only for the physics of the ocean, but also for the nutrients and chemistry, both for the ocean and for the atmosphere. Models are becoming more and more complicated as our knowledge of chemistry, biology and physics improves.

But the interesting things that not many people know is how interdisciplinary the expertise needed to run a climate model is. What we do with models typically is, first of all, you put all these equations in and then you want to test the climate model. You can run the model from the past to the present time, and then you compare it with observed climate and weather conditions over, let's say, the past hundred years. And this allows you to check the accuracy of the models, and if needed, to revise them. Then what you do is, first you compare your model output to observations and then you compare with results from other models. And once you're satisfied that your climate model performs well in this testing, you start to think about simulating the future climate.

Alex Schein:

Once scientists test the climate models against what they know about the past, they can run models for future scenarios. Professor Marinov focuses the majority of her research on the ocean. Understanding the ocean is key to understanding climate change because oceans absorb more than 90% of the excess heat we put in the atmosphere.

Irina Marinov:

The ocean, because of its huge size, regulates very much the heat budget on our planet. The next point, and the next number that comes to mind is that, in past few decades, the ocean has absorbed around 30% of all the CO_2 emissions from human activities. So of every 100 molecules of CO_2 that we put in the atmosphere, about half or 45% stay in the atmosphere, and the rest is divided approximately equally between land and the oceans. So again, the oceans have a very big impact on carbon cycling. So they take up CO_2 and they take up heat, basically mitigating climate change.

Alex Schein:

But that mitigating effect has its limits.

Irina Marinov:

Part of what we're seeing is sea level rise. Next, we are seeing melting of sea ice, particularly in the Arctic. The Arctic is warming much faster than the rest of the planet. We are seeing the large scale circulation changes in the ocean. As an example, our models predict that the Gulf Stream will slow down into the future because the North Atlantic, where the Gulf Stream sinks, is becoming warmer. Therefore, the entire prediction is that as the high latitudes are warming and freshening with more precipitation and more ice melt, we are going to slow down the large scale circulation of the ocean. This will have impacts on nutrient patterns. It will have impacts on carbon uptake by the ocean. And it'll have large impacts actually on ocean ecology.

Alex Schein:

In addition to oceanography and climate modeling, Professor Marinov has recently started to study climate change denial.

Irina Marinov:

There's good news and bad news on this topic. So the UN Development Program, the UNDP has recently commissioned a study called The People's Climate Vote. It's an Oxford University study that was released this year in 2021. They polled, through advertisements in mobile games in many languages, 50 different countries. And they'd ask the question, public opinion on the climate emergency. The good news is that, when analyzed across many regions, the proportion of people who believe the climate change is an emergency is pretty high across the world. And what's interesting is that GDP seems to matter. So the public belief in the climate emergency is higher in high income countries compared to middle income countries and then compared to least developed countries. That's the good news. The bad news is that, among the high income countries, the US is at the bottom.

Alex Schein:

Professor Marinov notes other interesting facts about climate change denial. In the United States, Canada and Australia, women and girls believe in the climate emergency at higher rates than men and boys. And in the US, unlike in most other countries, a person's level of education does not always influence their belief in or understanding of climate changes. Instead, political leaning is the biggest influence. She is concerned by this finding.

Irina Marinov:

It's a huge, huge separation. This divide of opinions takes precedence over education, gender and anything else. It's quite astounding. And I want to study more, but I doubt that anywhere else in the world, we're going to find these kind of separation with politics, which is puzzling to say the least, and absolutely needs to change because, naturally, there is no connection between climate change and politics. There should be no connection between climate change and politics. The ocean is the ocean, regardless of your political color.

Alex Schein:

While Professor Marinov studies oceans, Jane Dmochowski, senior lecturer in Earth and Environmental Science focuses on Earth.

Jane E. Dmochowski:

So how is Earth's vegetation changing with our climate? It really varies depending on where you are. In general, it's definitely changing. Some places are getting wetter and the vegetation's getting greener. In some cases, we can see evidence of plants that only really thrived in relatively warm environments moving farther north and farther south toward the poles. And obviously, as we're all very familiar with droughts, in California and Colorado and the western United States, we know that a lot of vegetation is becoming much drier in places where it used to remain green for a longer amount of time, becoming much drier, and also much more susceptible to fire.

Speaker 3:

Tonight, a growing threat as the giant Dixie Fire carves a destructive path, now the largest single wildfire in California history. The massive inferno, driven by historic drought conditions and winds, fueling a blow torch.

Alex Schein:

Like all scholars in this episode, Professor Dmochowski's interest in her field grew out of personal experiences. When she was an undergraduate at University of California, at Santa Barbara, there was an earthquake. That's not unusual for the area because Santa Barbara lies near several fault lines. A US geological survey study has predicted there is a 70% chance of a magnitude seven or greater earthquake occurring along the San Andreas fault by 2030.

When she was in college, Professor Dmochowski wanted to understand the earth around her and the plates beneath her. Now she studies vegetation's response to climate change using remote sensing imagery. She wants to help our students understand the Earth, its past and its future. Going on a fact finding mission about the Earth's 4.6 billion year history is a big task, but scientists know how to get answers.

Jane E. Dmochowski:

So we have a lot of information that helps us to understand Earth time. And one of the ways that we understand Earth time and understand different times along Earth's time scale is with radiometric dating. So most people are familiar with what we call carbon dating, using the carbon isotopes to date maybe artifacts or things like that. That has a relatively short decay. It's a short decay system. But most of the time, for geologic timescale, we use isotopes that have much longer decay systems like uranium to lead or potassium to argon. And we use these to then date rocks. And that's where the age of the rocks in Earth's timescale, that's how we get those times.

Alex Schein:

Scientists know the Earth has gone through a lot of changes in its long life. A lot of these changes are recorded in the Earth itself, in dirt, rocks, oceans, and trees.

Jane E. Dmochowski:

And so, when we look at a rock, oftentimes we see layers of rock as those sediments, over time, have deposited one on the other and created what we call beds of sediment, sedimentary rock. And we can look at those. And with radiometric dating, we can determine ages, but we can also determine things about the environment at that time. So were the rocks deposited in water? Were they deposited by wind? Were there animals living in that environment? If you found fossils, what types of plants were living in that environment? If it was fluid environment, was it really turbid? Was it fast moving water or was it really very still water? Things like that, that we can determine from the rocks, really help us to reconstruct Earth time.

Alex Schein:

Knowing that Earth's age and timeline is one thing. Understanding it is another.

Jane E. Dmochowski:

So in classes, I like to use a ball of yarn. Ahead of time, I've measured out this ball of yarn. So I can give the students a one to one of like what is an inch of this yarn compared to an amount of time. Couple of things that strike students typically is that you go through a lot, 70% of this ball of yarn, before there's any real life that they've heard of. Or even things occurring in Earth that they think of as really ancient history haven't even happened in that first 70% of Earth time. Another thing that they are always struck by is just how close to the point where I say, that very last thread of yarn that is human civilization, depending on how long my ball of yarn is, it's usually not that far since dinosaurs had just become extinct. And I think oftentimes they'll think of dinosaurs as like the beginning of time or really, really ancient history. When in the grand scheme of Earth time, they're really much closer to our current time than they are to the beginning of Earth time.

Alex Schein:

But you're not sitting in Professor Dmochowski's class looking at a ball of yarn. You're listening to a podcast.

Jane E. Dmochowski:

If you don't have the ball of yarn in front of you though, I think the best representation is really more of a calendar year. So if we sort of went to a calendar year and walked through our geologic time, we would then, at the very, very end, it would take the entire calendar year, get to just the last final minute before we actually had human civilization and what we know as sort of the industrial age, just the last second of that calendar year.

Alex Schein:

Understanding the Earth's past and caring for it in the present can protect its future. That kind of long term thinking is hard, but Jared Farmer says we're up for the challenge. Professor Farmer, Walter H Annenberg Professor of History, is an environmental place-based historian. He studies how non-human things affect human history. Things like, say, a virus. By now, we're all familiar with how much those can alter our lives. But also things like mountains, rivers and trees. Professor Farmer recognized the relationship between land and people as a child growing up in Utah.

Jared Famer:

You know, the most famous historical saying in Utah, supposedly uttered by Brigham Young, second prophet of the Mormon church, is, "This is the place." So that's the culture I grew up in. It's like, this is the place. So I was like, maybe it was inevitable that I became a place based historian. I was just trying to understand, what is a place? And how does one make a place? Places are not created by nature, right? They're not created through geological forces. Places are land farms, landmarks, landscapes imbued with human meaning. That's what a place is. It's a site of concentrated human meaning. And so, there's always a history to a place.

Alex Schein:

Professor Farmer has written books on rivers and mountains. And his next book focuses on trees, ancient trees, to be exact.

Jared Famer:

In my new project that I just finished, that will be out next year, I'm trying to take that place based environmental history approach, but to zoom out to the planetary. The tricky part is, I'm trying to do a place based planetary history, which is different than global history. It's different than a history of globalization. And it's not like an Earth history, the way that maybe an Earth scientist or geology would. But I'm trying to get at these very large scale planetary processes through very specific, indeed like hyper-local sites, places, I mean, individual trees. So basically my book is about individual ancient trees all around the world as sites that attract religious thinking, sometimes nationalist thinking, but also scientific thinking. So I'm really interested in this overlap of history of religion, history of science at ancient trees. And so these ancient trees are a way for me to think about these longer units of time, these kind of millennial, multi-millennial units of time.

Alex Schein:

Professor Farmer says that even before scientists could date ancient trees, people had a certain reverence for them and a protective instinct. Communities dated trees by what he calls relational age, saying things like, "That tree is as old as the temple." Dendrochronology, or tree ring science, made ages exact. And like rocks, trees can help us tell time. And we're not talking about a single lifetime. We're talking about deep time, time beyond the scale of human life. Professor Farmer wants us to take long looks back in time, and then long looks forward.

Jared Famer:

I think with climate change, we need to recultivate the arts of long term thinking, which is in our history. I mean, if you think about cemeteries, if you think of about genealogy, if you think about religion, these are all practices of long term thinking. It's in our history, it's in our past. People are good at long term thinking. I think it's just that, in my lifetime, the emphasis has been so much about faster, faster, cheaper, cheaper, crappier, crappier. Just shorter. I mean, short time has become everything. I mean, even long term shareholder value is like incredibly short, if you think of it.

So I guess with trees, I'm just trying to remind people of these existing cultural traditions all around the world of thinking of the long term, and how people have already been doing this with trees, have been doing it with universities. There are many universities that are hundreds, even over a thousand years old. But also, there are these relationships that people have with trees that are extremely old. And the trees themselves, the specimens themselves are often hundreds or thousands of years old. But then species or the genetic lineage is often exponentially older than that.

Alex Schein:

For Professor Farmer, trees offer an emotional access point.

Jared Famer:

People have deep feelings about trees. There are all these mythologies about trees. There are famous and iconic and emblematic trees all around the world, protected trees, national parks, natural monuments that protect trees, trees are tourist sites. Trees are on flags, t-shirts. It's very common for people to love trees, to hug trees. I've never met somebody who hates trees. You might hate a specific ginkgo, female ginkgo perhaps, if it's in front of your house. But in general, people love trees. And so, I think because there is that kind of built in emotionalism about trees, in part because people personify trees, that is a great way to kind of introduce people to this concept of long time, which itself as an introduction to deep time.

And so I'm trying to kind of just work with some existing, very deep kind of human traditions of veneration for old trees. By appreciating our long term relationships with long lived beings, we can remind ourselves of our own ability to think and live in the long term and maybe achieve a better balance between, again, living as multi temporal beings. And I think that's just so important right now. Because not only do we need to live in the past, in the present and the future, we have to extend that future into the deep future, because we are making changes that will last for millennia. And so, how do we do that? How do we think forward?

Alex Schein:

In order to address climate change, we have to act now, in our time. And we have to do so with the future in mind. Are we capable of that? Can we imagine a future and bring it into being?

Jared Famer:

I sort of think of old trees as being these gifts. People don't make trees, they plant trees. And they cultivate trees. You can breed trees. The trees are not of us. Trees are very, very old plants. They're much older than animals. And if you think of gymnosperms, these are incredibly old, genetic lineages. Anyway, so trees are not of us, but they are gifts to us. I really believe that. They're ethical gifts, as well as intellectual gifts, as well as spiritual gifts. But they're gifts because they make us more human, because they allow us to really use our mental and emotional and spiritual faculties to their full extent.

Alex Schein:

Professor Farmer knows that human beings have some protective instincts when it comes to the natural world, from ancient trees to places like the grand canyon. He wants us to lean into those instincts and appreciate our time on Earth with the future in mind.

Jared Famer:

It's going to be a harder world, but I want to hope that it can still be a fairer world. And the oldest beings of that world, they already exist. They're young trees now, but they can be old. So to think about not just future generations of people, but to think about the future oldest non-human things, the future elder flora. I just think that is really exercising our full potential as humans. Trees are this gift that allow us to be fully human by living in time and place here on Planet Earth.

Alex Schein:

This wraps up episode seven, Climate Change, and the Problem with Time, and concludes season three of In These Times, Fear and Loathing and Science. The OMNIA Podcast is a production of Penn Arts and Sciences. Special thanks to Irina Marinov, Jane Dmochowski, Jared Farmer, and all of our guests this season.

In These Times, season three was produced by the OMNIA Magazine editorial team, Blake Cole, Lauren Rebecca Thacker, Susan Ahlborn, Loraine Terrell, Brooke Sietinsons, and Evan Smith. Our theme music was composed by Nicholas Escobar, college class of 2018. Our logo design and episode illustrations were created by Dan Lee. I'm Alex Schein. Thanks for listening.

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