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00:06 Sarah Crespi: Welcome to the Science Podcast for August 28th, 2020. I'm Sarah Crespi. First up this week, staff writer Paul Voosen talks about new ways to lose sea ice. It turns out that rapid loss of Arctic sea ice is not due to just hotter air, but also things like dangerous hot blobs of ocean water. Next, Damien Fordham talks about how paleo-archives of what happened to biodiversity and ecosystems during different climate change scenarios in the past can help with prediction and conservation under human-induced climate change. And in our book segment, Kiki Sanford talks with author Carl Bergstrom about his new book, Calling Bullshit: The Art of Skepticism in A Data-Driven World. First up this week, we have staff writer Paul Voosen. He wrote on new processes that are killing off Arctic sea ice even faster than previously thought. Hi, Paul.

01:06 Paul Voosen: Hello.

01:07 SC: Well, bearer of good news, as usual. Your story starts with the Polarstern. This is a ship hosting the MOSAIC mission, Multidisciplinary Drifting Observatory for the Study of Arctic Climate. And we've actually talked about the Polarstern on the podcast before, but surprisingly, the mission came to an early end. What happened? They were supposed to be in the ice for about a year?

01:34 PV: Yeah. The mission's not over, it's just re-thought. So they had done projections on how fast the ice travels, how far it goes, and putting all that together, they thought, oh, we freeze in this spot, we should stay in a floe for a year, but the ice just moved faster in a very straight line, and so it got out in eight months and it's pretty much fully dissolved after eight months.

01:58 SC: And the researchers were like, okay, we're no longer stuck in an ice floe like we planned, but we also got to see the end of an ice floe, which wasn't something they expected to observe.

02:08 PV: No. And now they are back up in the North Pole trying to look at a new ice floe and catch ice floe formation up there 'til it ends in October.

02:19 SC: We know that Arctic sea ice is disappearing year over year. A lot has been lost since the 1980s. 75% by volume has disappeared since then, but what we're learning now is that it's not just hot air doing the damage to the ice, but it's also things like dangerous heat blobs. What's this all about?

02:38 PV: The Arctic is unlike the Atlantic or Pacific Ocean. It's fundamentally shaped by the ice on top of it. Because of that ice, you have this cold fresh water, and then beneath it, you have this layer of Atlantic warm salty water. That salt makes it heavier, and so the Arctic Ocean actually gets warmer as you go down, and this water has been locked off. It doesn't reach the ice, it can't interfere with it, it can't melt it, and there are now initial indications that it is starting to melt off the ice for parts of the Arctic.

03:14 SC: So it's cooking the ice from underneath?

03:16 PV: Mm-hmm.

03:17 SC: Is it getting bigger, or is it getting higher up in the sea? What's happening, and what's causing it?

03:22 PV: There was a new study in the Journal Climate that just came out last week that provided the first indication that the warm blob is actually starting to melt ice. Before that, it's been more of a threat, but not one that had been realized. There are two potential ways it's being fed. You have the ever warmer Atlantic waters traveling farther north and getting in there, more of the waters and they're warmer, and also, as the ice retreats around the margins of the Arctic, more of the Arctic Ocean is being exposed to heat, and these heated marginal waters, there's a theory that they end up deep down under the ice and contribute to the warm blob.

04:03 SC: In addition to the warm blob, we also have faster currents. The water itself is moving around more quickly. How is that affecting the sea ice?

04:13 PV: This is not a totally verified thing. There are indications, they're not all published, so take it with a grain of salt. It makes sense if you have more ocean exposed to the wind, the wind can catch the ocean and move the water faster, so it makes physical sense. And then this might also start moving the ice around faster, shunting it into warmer spots where it might be more prone to melt.

04:38 SC: The last effect you talk about is rougher ice, so not only is the ice being warmed, but it also is basically easier for the wind to catch hold of and shove around?

04:50 PV: One big question about the next couple decades of the Arctic is, as we move to this first-year ice, it's called, it's thinner, only lasts one year before melting, how does that change the behavior of ice? Is it more prone to deformation, to crumpling, and then if it crumples more, it catches the wind. It's not clear, that thin ice you might think, oh, well, that should crumple easier. That could be true, but it's still not clear if that overall will lead to more crumpling everywhere because thicker ice can actually potentially hold on, just gets more wrinkled with time, and so it's not a clear question, or answer.

05:27 SC: This is where the space lasers come in.

05:29 PV: Yes. So in 2018, NASA launched ICESat-2, which is a laser altimeter, measures the bumpiness of the Earth's surface and ice in particular and snow, and they're really providing for the first time a clear picture of summer sea ice, which is something of the three dimensions of summer sea ice, which has always been this vast white blank canvas with a lot of puddles on it, and now you can start to really tease out some of these things that MOSAIC might see at this local floe scale, extrapolate them to the Arctic overall.

06:01 SC: Another mission, or another research project, that's underway that is also looking to see a very large portion of the Arctic all at the same time is this group of research vessels, I think that you said it's 12 research vessels all going to the Arctic at the same time?

06:18 PV: Yeah, so it's called the Synoptic Arctic Survey. It's a bunch of national missions coordinated in time, they all have their individual funding, they're all supposed to go this summer to provide this baseline measure of the Arctic, rather than these individual snapshots that you tend to get. That's been totally disrupted by the pandemic. Most of them will hopefully go next summer, a couple are starting right now.

06:41 SC: And is this unusual for so many ships to be there at the same time?

06:45 PV: It is. It hasn't been coordinated like this, and also more ships can get up there now with less ice.

06:52 SC: We have less ice, the Arctic is changing, but it's maybe easier to observe.

06:56 PV: Yeah, easier to go in a ship, but you'd wanna step on that ice a lot less.

07:02 SC: We're learning the ice is going away in a bunch of different ways. What do we do with this information? How does it help us understand climate change? Is it just bad news?

07:14 PV: Even the most optimistic scenarios have... Even if we start cutting emissions... The sea ice will probably disappear for the summer in the next couple of decades. It's likely not stoppable, but this is not a tipping point. This is something that if we cut emissions, eventually the ice will start reforming again. Not irreversible, but the Earth takes... [chuckle] Even fast systems like ice can take decades to reverse. So steps we take today will eventually change the future of it.

07:46 SC: What do we take away from all this?

07:48 PV: These different feedbacks that are coming up will help us gauge when the ice will go in the summer, which will be important, politically important, geopolitically important for national security, and also shipping, all of that, and then once we understand how it goes, that might help us figure out how it comes back.

08:06 SC: Alright, Paul, thank you so much.

08:08 PV: Yeah, you're welcome.

08:08 SC: Paul Voosen is a staff writer for Science. You can find a link to his story at sciencemag.org/podcast. Stay tuned for an interview with Damien Fordham about predicting the future of ecosystems under climate change by looking back in time.

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08:29 SC: Climate change is heating up. Globally temperatures are reaching a high not seen in more than a million years. This week, Damien Fordham and colleagues write a review in Science on how new tools that help us look far into the past at very old climate change events can help us protect biodiversity today as climate change ramps up. Hi, Damien.

08:52 Damien Fordham: Hi, Sarah. How are you?

08:53 SC: I'm good. Your review looks to the past to help predict the future. What is going to happen to biodiversity, to ecosystems as the climate changes? Why is this an important source of information for what might happen in the next century or two?

09:10 DF: It gives us critical reference points in Earth's history to identify things like ecological processes and characteristics that influence the extinction risk and ecosystem change. One other thing it can do is it can give us this opportunity to I suppose determine the resilience of biodiversity to abrupt climate-warming events.

09:29 SC: How far back are you looking? Are there certain periods that are really useful to think about?

09:35 DF: We focused on a period that we call the late quaternary. So the quaternary itself goes back two and a half million years. We've really focused on the last 130,000 years to really see if we could find periods and regions of the Earth that have experienced climate conditions that are warmer than the 20th century, quite similar to today, and periods when regions have experienced rates of warming that are similar to what is being projected for the 21st century.

10:01 SC: You mentioned in your review that this is easier to do now that we have better tools and better, I guess, access to the past. Can you describe some of that evolution in the techniques?

10:13 DF: We've got an ability to date with a fair amount of precision, and we're able to do that at a much cheaper cost. We've also got incredible molecular tools now with the taking off of genomics, which allows us to really open a window into the past in terms of demographic responses of species, and even potentially evolutionary responses of species.

10:36 SC: Some species that are alive today have been through 20 cycles of cooling and heating, or glaciation and deglaciation. What are some examples of responses to climate change that happened in these past millennia?

10:50 DF: We have been able to show and identify ecological responses such as large range shifts. We're talking here, shifts of hundreds to thousands of kilometers in response to ancient warming events, and then these have had knock-on effects. So we've seen community shifts, and this in turn affects things like ecosystem services, so the things that we rely on today, and in terms of primary productivity, nutrient cycling, etcetera.

11:19 SC: Can you give examples that people might be familiar with: The locations, or the animals, or species?

11:25 DF: In terms of looking to species that have responded to these warming events, back in the last interglacial, so this is a period about 130,000 years ago, the world was as warm as it is today, if not warmer, and what we saw in this time, we saw hippos in the UK. They had expanded their ranges up into the UK. And a good example from America is in the Midwest. There were giant tortoises roaming around. And believe it or not, at this same time, the Sahara was green, and it was caused potentially, to some extent, by warming in the north of Africa driving the monsoonal rains south. So a very, very different world.

12:07 SC: And I think that really points out this systems approach that you take in the review, the idea that you're not just looking at the movement of one animal, you're looking at the effect on biodiversity and the effect on a whole group of interacting organisms.

12:23 DF: The aim of the review was really to look at biodiversity and its different facets, from the gene right through to the ecosystem, and I think this is something that was really quite novel that we managed to do in this paper. In doing so we were able to then try and quantify, at least provide a stronger understanding of how these different elements of biodiversity respond to a warmer world but also respond to abrupt warming, so rapid warming. And from that, we can really start to take these lessons into conservation and use that to inform policy.

13:00 SC: We don't have all the answers now, but what are some of the big lessons you think we've learned so far from looking at the past through this lens?

13:06 DF: We know that species' ranges will shift, and we also know that when these species' ranges shift that they will change the composition of communities. One of the other lessons that we've learned a lot from the past is that species respond to climate warming at different rates. The whole community doesn't shift as one. Consequently, you can actually see non-analog communities, so communities that haven't been seen before, due to these climate warming events.

13:35 SC: I think not a lot of people know that this isn't the first time that warming of this rapidity, this speed, has been experienced on Earth, but you do talk about that in your paper. What are some parallels that you've seen in the past?

13:49 DF: By focusing, particularly here, on the last 20,000 years, as the Earth emerged from glacial climates. During this period, there were actually a number of periods of very, very fast warming, warming in a matter of decades, warming in terms of half of the temperature increase that happened between the Ice Age and modern conditions, so imagine that happening in just a matter of decades.

14:13 SC: Wow.

14:14 DF: In some areas, this is up to 10 degrees Celsius. So we've been able to identify some of those periods and then actually look and compare them to future rates of warming. And we can see particularly in areas of the Arctic, Eurasia, Amazon, and New Zealand, that there have been periods that are quite comparable to the future. And so then what we can do is that we can go through and we can understand biotic responses to these very fast warming events, and these are periods where we saw large shifts in abundance, so downward trajectories in abundances, we saw a lot of species moving around, and we started to see local extinction events.

15:00 SC: Are there important differences that we should keep in mind when comparing the past climate change that we've seen to human-induced climate change? What's happening now?

15:08 DF: Yeah, no, I really think there is. And that's a great question. So the world that we're looking at, for the 21st century, is really quite a unique climate realization in Earth's history. We need to actually go further back than the last 130,000 years, in fact, we need to go back about three million years to the Mid-Pliocene or possibly even 50 million years to the Eocene, for conditions when CO2 levels are comparable or higher than today. So this is a long time ago. And the world then was really quite different to what we're seeing under future climate change. Take, for example, if we look at the poles, going into the 21st century, we still have a lot of polar ice. In these periods, the polar ice was greatly reduced, and this resulted in large sea levels. So in terms of the work that we've done, we're not looking at true climatic analogs of future global warming, but what we are able to do is we are able to ascertain ecological responses to what a warm world would look like and also to fast rates of warming.

16:13 SC: This is a thinking tool, as you say, this is a way of looking in the past and seeing patterns and thinking about how those patterns might apply to the future. How can those be turned into action on the part of humanity? How can we apply these lessons to conservation, to preserving biodiversity?

16:33 DF: I think this really is something different to what has previously been put on paper or put in the scientific literature. We've actually tried to come up with a common currency in terms of metric, so we've tried to develop or at least show that metrics and ways in which we can calculate rates of biodiversity change in the past. I'm not all that dissimilar to how we're going about trying to record current biodiversity loss and use that for managing future biodiversity in terms of setting targets. We can actually use these metrics, and these are metrics that cover from population declines, to changes in species distributions, to shifts in communities, to even shifts in ecosystem function and services, we can take this information and we can learn directly from it. So we can actually start to understand what an abrupt warming event means for species in terms of shifting their distributions, in terms of their population trajectories, for we know that the population trajectories of many, for example, called adapted species, went through major, major declines in response to these warming events and especially these abrupt warming events.

17:47 SC: What do we need to learn more about? What do you think are the next steps for developing this thinking or this approach?

17:55 DF: In terms of paleoclimate and climate science, it would be nice to be able to actually generate full transient climate change models over the last 100,000 years, global reconstructions using models of the climate since the last interglacial period. We could be looking to build on the great efforts that are being made to make a lot of this Paleo data open access, so that people like myself can use their modeling tools and skills to access this and to generate the types of models that will be so informative for biodiversity conservation going forward. In terms of the genomics, it would be great if there continues to be such a heavy focus on community-scale sequencing of biological remains preserved in permafrost, ice cores, marine, and lake deposits. There is the possibility, hopefully soon, that we'll be able to even unravel the ability of populations to adapt genetically to rapidly changing climate conditions. I mean, quite a holy grail, but I think the technology is getting there.

19:00 SC: Thank you so much, Damien.

19:01 DF: It's a pleasure, Sarah. Thank you for having me.

19:03 SC: Damien Fordham is a professor and global change ecologist at the University of Adelaide's Environment Institute and School for Biological Sciences. You can find a link to his review at sciencemag.org/podcast. Don't touch that dial. Still to come is Kiki Sanford's interview with author Carl Bergstrom, on his book, Calling Bullshit: The Art of Skepticism in a Data-Driven World.

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19:31 Kiki Sanford: Welcome to the book segment of the Science Podcast. I'm Dr. Kiki Sanford. The following interview contains mild profanity.

19:39 Carl Bergstrom: Yeah, so the sort of origin story is that Jevin West, my co-author and I have been good friends and collaborators for a very long time. Jevin was gonna be teaching a new course on Big Data, and he was telling me about it, and I said, "Okay, well, that's good. I'm gonna teach a class called Calling Bullshit on Big Data," 'cause I've kinda been a bit of a skeptic about that, and he laughed and said, "Man, I'd love to teach that with you."

19:57 KS: One thing led to another, and soon enough, University of Washington professors, Carl Bergstrom and Jevin West, weren't just teaching a class. Dr. Bergstrom sat down with me to talk about the book that came out of it, Calling Bullshit: The Art of Skepticism in a Data-Driven World. Thank you for joining me today on this Science Podcast, Carl.

20:16 CB: Great to be here.

20:17 KS: What originally got you thinking about bullshit?

20:20 CB: My PhD is in studying the evolution in communication. So, I started out thinking about communication and manipulation, and what makes communication honest, and when can animals lie to each other, and how does that work. And these questions have been of interest to me throughout my entire career.

20:35 KS: The chapter called The Nature of Bullshit describes some examples of animal deception. Why was that important for you to include in a book about human deception?

20:43 CB: The thing about communication is that when we communicate, that gives me direct handles over your behavior. So, if the things I was telling you weren't gonna in some way influence your behavior, there would be no reason for you to pay attention, at least in some sort of evolutionary context, right? Especially thinking about animal signals. Once you start having organisms having direct handles over one another's behavior, but they've got somewhat conflicting interests, that sets up these really interesting dynamics, where deception becomes possible, but not too much deception, otherwise the signal wouldn't be heated at all. So, it was fun to get to at least nudge at that in the book, then to point of bullshit isn't something that started when AOL joined the Usenet. It's something that goes way, way back.

21:23 KS: Tell me about the distinction between old school and new school bullshit.

21:28 CB: Old school bullshit is the sort of weasel wording, and you hear it from a corporate spokesman or a political figure making excuses, or whatever. I think we're all pretty sensitive to that. We live in a world that is, as we say, saturated with that sort of stuff. We know how to pick that up. We're not as good as I would like us to be, but we know about that kind of stuff. What we see more and more of as the world becomes more and more data-driven, and as we see this new school bullshit that comes clad in the trappings of statistics, and quantitative figures, and data graphics, and that sort of thing. And I think we're much less facile at challenging bullshit in that form.

22:04 KS: Do you think we can learn to challenge the new school bull?

22:07 CB: Even without a master's degree in statistics or a technical background at all, you don't need to let yourself be pushed around by numbers. Someone comes to you, and they've got the numbers. You don't have to just back down and say, "Okay. Well, I guess you've got the numbers." Or if they've got a statistical analysis, and you don't understand the stats, you don't have to just agree with their conclusions. Just by thinking clearly about what's going on, and knowing a few basic principles, you can see through this stuff, and you don't need to be vulnerable to this kind of bullshit that we're seeing more and more of, and is used to people's detriment all the time.

22:38 KS: Do you have an example?

22:39 CB: If you think about a selection bias problem, and you think okay... There's these two doctors in Bakersfield, who are saying that they can estimate the fraction of people in California with COVID. And they're saying that because some percent of the people that come to their clinic are positive for COVID, that must be the percentage that's positive in California. You don't have to have any mathematical training at all to say, "Well, wait a minute. Why do people go to the clinic during the middle of a pandemic? It's because they think they've got COVID, and so, of course, they're getting really high numbers there, and it's a massive over-estimate of the prevalence in California. These are the kinds of lessons that we try to teach, and this is the way that you can call BS, without having to look into the statistics.

23:16 KS: How do you go about teaching people to be more inquisitive about the information that they're getting? Is there a basic level of mathematical numeracy that people need to have to be able to start addressing this, or can it be addressed more generally?

23:32 CB: I think it can absolutely be addressed more generally. In our course, there's no mathematical prerequisite. We don't expect anybody to have any mathematical background. We think about the statistics, or the machine learning concepts, or whatever, as a black box. You can leave it as a black box, because 19 times out of 20, when someone gives you a bullshit claim, the bullshit isn't in the black box. It's not some artifact of the technical procedures. It's that people have put in the wrong data, or taken the wrong conclusions from the output. And so, that doesn't require any kind of mathematical sophistication. I think this is so important in a world where, more and more, we are expected to make our decisions and form our beliefs based on data.

24:13 KS: From your experience, and I mean, you're very vocal on Twitter, have you found it worthwhile to call bullshit on people online?

24:23 CB: I think that the calling bullshit can be useful, if you choose selectively what to call it on. I mean, you can't hope to shout down every piece of misinformation out there on the internet. Now, there's something called Brandolini's Law, and Brandolini's Law may be the fundamental law of bullshit studies, which is that it takes an order of magnitude more effort to refute bullshit than to create it. I'd say two orders of magnitude, probably, now, based on empirical experience. In other words, it's sort of a losing battle, if you're gonna try to sweep up all of that stuff. On the other hand, there are pieces of misinformation that become very, very prominent and need to be tackled by people who have credibility in the scientific community, so that the news media and others can say, "This is not a credible claim, this is why."

25:13 KS: And then, we have to deal with the added challenge of the algorithms that help spread misinformation.

25:19 CB: Part of the trick is to figure out how to use that for good, instead of using it just for information to spread further. And the challenge there is that so many of the algorithms that get used on social media, the poll user experience, plus the underlying algorithms, are designed to maximize engagement. Engagement is linked to how shocking, and startling, and surprising things are, not to how accurate they are. And so, you've got this system that's really put into place to maximize the spread of extreme ideas. And so, trying to figure out how do we counter that, and take this infrastructure that could be used in very, very powerful ways, and increase the degree to which it's being used for good.

26:00 KS: Yeah. If Google's motto were still "Do no evil"...

[laughter]

26:06 KS: Maybe their algorithm for YouTube would be a little bit different. [laughter]

26:08 CB: This is one of the single best examples. Jevin has this great story about how he and his son are watching live feed from the International Space Station, and the sidebar is full of flat earth videos. But that's 'cause of the algorithms have learned that you get pushed toward more and more extreme content, and that's a regular feature of the YouTube algorithm.

26:26 KS: What approaches can we take to solve this obvious problem?

26:30 CB: How do you deal with the fake news problem? How do you deal with misinformation? You could try a technology, and there are a lot of people claiming that they've got artificial intelligences that can detect false news. I'm very pessimistic about this. I think the problem is very, very hard, even as it currently stands, and then if we start to get good at it, then the nature of fake news and misinformation will change. You can use antagonistic machine learning to find ways to get around the machine learning filters that are catching this. So, I don't see this ever being a winning game.

27:00 KS: What about regulation? Should the government get involved?

27:02 CB: I'm cautious about regulation, because I do strongly support a broad interpretation of First Amendment rights. There are certain things that probably should be regulated. I'd like to see people have more control over the information that they get through their social media feed. I should be able to turn off the filter that Twitter puts on what I see and just see the things that people I follow post in the order that they post them. So I'd like to see that sort of thing. We should be anti-targeted political advertising, absolutely. Allowing people to find tune ads to a very small number of people in a possibly really noxious demographic, and do it in a way that's dark so that no one ever knows that they ran that ad. The way people find out if I run a racist ad during Super Bowl, everyone knows I ran a racist ad, but if I push it to 500 people in one particular location, in one particular demographic, that may never even be detected. That shouldn't be going on. But regulations really, there's only so far we can go with that.

27:57 KS: So far, this seems rather defeating. Is there anything that might actually work?

28:03 CB: What Jevin and I see, is the third leg of the stool and the only one you can stand on is education. And we feel like we need to catch up in terms of teaching people how to be informed consumers of media. This is what our course is about, and this is what so much of what people are trying to integrate into high school curricula now. The state of Washington now has media literacy in its state's standards, which is extremely important step. I think that's gonna be a really key piece. We're in one of these mismatched situations where our technology has gotten a little bit out ahead of our education base for dealing with it, and so we're obviously suffering from that right now, but I do think we can catch up.

28:38 KS: Looking forward now, is there a take-home message from the book that people can use?

28:46 CB: I think there's a lot of it. We all need to be constantly working on our bullshit detectors and so on, but with practice, you can get quite a bit better at it. One of the things that we teach the students and that we use all the time, is if something seems too good or too bad to be true, it probably is, and when you see that, track back to the source. So I think that's a key example that over and over again plays out in COVID, because we'll see these claims getting made around COVID that are these extraordinary scare stories. And you track back to the source, you can see these things aren't well documented, and this was probably organized propaganda from opponents of the Chinese Communist Party at the time.

29:22 CB: Same thing if things seem too good to be true. Somebody gets on national television and says that hydro chloroquine is gonna cure this and is the mystery cure, and it's just there's a cover up on the part of the doctors of the country to prevent us from using it, then that person is probably not telling you the truth. And even if that person is, say, holding the highest office in the land, you still wanna track back to the source of those claims and try to understand where is that argument coming from. Oh, okay, he's got a doctor who thinks that we're making vaccines out of alien DNA. That's his source, and then my source are these large randomly controlled trials that say it doesn't work. Who do I wanna believe? Those kinds of lessons are fundamental.

30:01 KS: How does somebody tell the difference between those two things?

30:05 CB: This is really hard, and it's... That one is a really tricky one. We've had some other examples like this, say John Ioannidis out of Stanford with his contrarian view about the virus, extremely established, very well-respected epidemiologist that is making these claims. So what do you do about this? And I think the trick there is really to triangulate. Try to look at a range of opinions, and if they're across the board, and particularly if the one you're hearing is an outlier, then that gives you a lot of reason to at least hold some doubt in your mind. Triangulating is a ton of work, and so one of the things I really strongly encourage people to do is to identify and follow the very best professional reporters that work on these things.

30:47 KS: Yeah, I think that's great advice. Thank you so much, I really appreciate getting to talk with you.

30:52 CB: Yeah, that was fun.

30:53 KS: And thank you for joining me for this interview with Carl Bergstrom about his book, Calling Bullshit: The Art of Skepticism In A Data-driven World. I'm Dr. Kiki Sanford, and I hope that you'll join us again for a peek between the pages of another science book.

31:08 SC: And that concludes this edition of The Science Podcast. If you have any comments or suggestions for the show, write to us at SciencePodcast@AAAS.org. You can listen to the show on the Science website, that's Sciencemag.org/podcast. On the site. You will find links to the research and news discussed in the episode. And of course, you can subscribe anywhere you get your podcast. The show was edited and produced by Sarah Crespi with production help from Podigy, Megan Cantwell and Joel Goldberg. Jeffery Cook composed the music. On behalf of Science Magazine and its publisher, AAAS, thanks for joining us.