Q&A: Kate Marvel on the physics and emotions of climate change

The astrophysicist turned climate physicist connects science with people through math and language.

By Jenessa Duncombe

"Climate change is not an asteroid hurtling toward us that we can't do anything about," says Kate Marvel. A climate physicist at NASA's Goddard Institute for Space Studies (GISS) in New York City, she sees climate change as a solvable problem. Initially interested in astronomy, she pivoted to climate science during her postdoctoral studies. Her work approaches Earth's climate from a global perspective, and she served as a lead author of the US's Fifth National Climate Assessment, released in 2023. "We understand climate change, which means we know how to fix it," she says, "and that is a beautiful thing."

One of Marvel's passions is talking about climate science. Her 2017 TED Talk on clouds and climate has more than 1 million views, and she's appeared on *Meet the Press* and *The Ezra Klein Show*. Her first book, *Human Nature: Nine Ways to Feel About Our Changing Planet*, was published in June. But she says she doesn't see herself as a science communicator. "I am a writer, and I write about interesting things," she says. "And the most interesting thing in the world to me right now is climate science."

Can you tell me about your path into research?

Unlike probably most readers of *Physics Today*, I did not want to be a scientist when I was a kid. I thought high school physics was boring. It focused on stuff like balls rolling down inclined planes, and I didn't care about that. Then, in college at the University of California, Berkeley, I took astronomy. The class was amazing. I learned that there's a black hole at the center of our galaxy and about the Big Bang. The idea that physics could describe interesting things blew my mind.

My long-term plan had been to double major in drama and something like philosophy or English and, after college, to go be a movie star. Instead, I decided to switch my major to both astrophysics and physics.

What did you study in your doctorate in theoretical physics?

I was interested in the cosmological constant problem, which is the enormous disagreement between quantum theory and experimental data on the value of vacuum energy. A lot of my PhD work at the University of Cambridge was on what are called Coleman–de Luccia instantons. I studied bubble nucleation as a possible resolution of the cosmological constant problem.

During that time, I got used to the idea of math as a language. I don't consider myself particularly good at math, but I learned to use it as the language in which we describe reality. Learning this also made me a little bit omnivorous, willing to try to use math tools for any problem even if they are typically applied in other areas of study.

Can you give an example?

In my first postdoc, at Stanford University, I ended up using random matrix theory—which was originally developed for atomic physics using Wigner matrices—to model

Kate Marvel (Photo by Elisabeth Smolarz.)

the instabilities in the electric grid.

How did you get interested in climate science?

Some contacts recommended I try climate modeling during my first postdoc, so I went and talked to climate modeler Ken Caldeira. We ended up writing this crazy paper together. It was about hypothetically putting wind turbines in the jet stream. If we did that, how much energy could be extracted before we shut down global wind?

I was intrigued because the research question was nuts. I came from astrophysics, this field that tries to explain the entire universe. And I found myself being surprised that we didn't know how much wind we have in the jet stream. I liked climate science because it addressed questions that seemed big and interesting and expansive but also relevant.

I also came from a hypercompetitive theoretical-physics department during my PhD where every seminar felt like a blood sport. Going to a seminar in climate science, I noticed that people were asking questions about things they were curious about as opposed to feeling the pressure to know everything. I liked the culture a lot better.

Tell me about your journey to NASA.

After my second postdoc, at Lawrence Livermore National Laboratory, I moved to New York because my husband got his dream job there. I made this move for personal reasons, meaning I couldn't apply to academic jobs just anywhere because I had geographical restraints. I basically talked my way into a soft-money job in 2014 at NASA GISS through Columbia University. I had to raise my own salary. It was hard being on soft money. I had the opportunity to become a civil servant in 2024.

I find the expectation in academia that you are supposed to move all the time and you are not supposed to have a family pretty silly. I have felt supported by my immediate group at NASA.

What are you working on now?

I study physical and biogeochemical feedbacks in the climate system. How will clouds rearrange in response to warming, and how much will this affect the global temperature? And how will climate-induced changes to natural systems affect the amount of carbon dioxide that the biosphere can take out of the atmosphere? I'm fascinated by what the climate states of the past can teach us about the future. I use Bayesian methods to draw inferences from data; those methods are a language and way of seeing the world that makes sense to me as a physicist.

You did a one-year stint in 2023 at the nonprofit Project Drawdown. The organization conducts research on and helps implement science-backed climate solutions. What did you take away from the experience?

When you look at climate change from my global perch as a researcher, it can seem overwhelming. But when you get down to the nitty-gritty, you see that the solutions are almost boring, like balls rolling down inclined planes. And I find that comforting.

We know what is causing climate change. To use particle-physics language, this is like a 10-sigma thing. We know exactly what is making the climate get warmer, and that means we know exactly how to stop the warming. And so Project Drawdown is, in my mind, the absolute best science-based nonprofit thinking about what we can do. I did some attribution work thinking about the relative roles of aerosols versus methane versus carbon dioxide. I learned a lot about where emissions come from and possible solutions for reducing those emissions. Working there actually made

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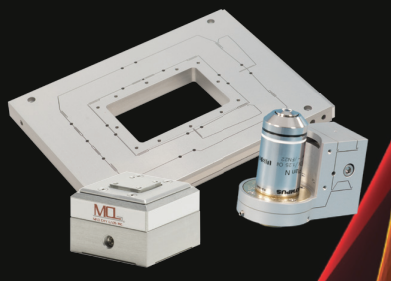
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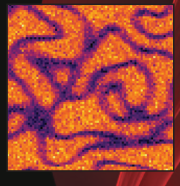
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What inspired you to write your first book?

I always knew that I wanted to write a book because I see myself as an artsy person who also fell in love with science. The book makes the case that you don't have to choose between getting the science right and being a whole, thinking, feeling human being who is drawn to stories and the arts and history.

The book uses nine different emotions as a lens to look at climate change. In each chapter, there's an emotional through line, a scientific through line, and a story through line. The guilt chapter, for example, is about attribution science. It talks about how climate scientists know that humans are causing climate change. But it also mentions historical climate change. In Europe during the Little Ice Age, you start seeing a spike in the number of people being accused of witchcraft. It's fascinating to me because that is something that we as physicists are not equipped to understand. $F = ma$ doesn't apply to people's emotions. When you apply force to a person, what's going to happen?

Do you have any advice for scientists who like writing?

I'm in a writing group, and I love it. We've got two stand-up comedians, two people who are writing young adult fiction, and two people who are writing amazing, gorgeous novels with the most exquisite sentences. The diversity of writing has been great because it drags me out of my scientist mindset. And being able to get feedback from people who I have been working with for eight years now is great. That's my top advice—find a writing group of people who are better writers than you.

People tend to react strongly to climate change because it has been politicized. What is your perspective on strategies for writing about climate change in a way that reaches people?

Be honest, and don't pretend to know stuff you don't. We're all human and entitled to our political beliefs, but our expertise in science doesn't give our views more weight.

Is there anything you want to address with respect to the changes to federal science policy in the US this year?

Science is an important part of our democracy. Attacks on science writ large are attacks on democracy. They're attacks on the ability to know things that we are not just told by people in charge. And for me, it's important to make that connection. I take a lot of pride in being a publicly funded scientist. Whatever we find out, whatever we know, that's for everybody: That's for the American people