

A Young Scientist, Undaunted

An interview with Ilissa Ocko

By Miriam Horn



Ilissa's doctoral research at Princeton used sophisticated climate models to simulate how aerosols like sulfate and black carbon scatter or absorb sunlight, with corresponding cooling or heating effects.

On October 7 the Intergovernmental Panel on Climate Change (IPCC) released a landmark report delivering alarming news: with dangerous climate impacts barreling down on us, we must rapidly transform every aspect of our lives. Just a few days later, Hurricane Michael provided a foretaste of the predicted loss and suffering, smashing the Florida Panhandle with 155-mile-per-hour winds, killing at least forty-five people and wiping entire towns off the face of the Earth.

Following a year of record-breaking storms, floods, heat waves and wildfires, plus relentless attacks by the Trump administration on America's essential environmental safeguards, it was hard not to feel like the game was up: climate change had become too overwhelming a challenge to meet. It seemed an opportune moment to check in with EDF climate scientist Ilissa Ocko to help make sense of recent events and understand why she's more energized than ever.

Ilissa, let's start with the year's disasters: What do they tell us about the advance of climate change?

You can trace the climate connection to everything we're experiencing. The wildfires, for instance, that scorched California and the entire West. Since 1970, we've had triple the number of large wildfires; the fire season is now eight months long instead of five, and six times more acres burn. That's all connected to the hotter temperatures we've been experiencing, which are clearly tied to climate change. Excess heat dries out the soil and wood, so all are more flammable.

These more damaging hurricanes are also tied to climate change. A major reason for Hurricane Michael's abrupt strengthening from a Category 2 to a Category 4 storm—in less than 24 hours—was the higher-than-average temperatures of the sea's surface. Warmer waters evaporate more quickly, fueling storms as they pass. With sea levels along the southern and eastern U.S. coastlines eight to twelve inches higher than a century ago, storm surges travel further inland, flooding a larger swath of homes, farmland and power grids.

Arctic warming appears to be affecting these storms and other weather patterns around the world by changing the jet stream, which is like a river of air in the atmosphere crossing the mid-latitudes and creating our weather patterns. When there's a strong gradient—a very cold pole and warm equator—the jet stream is tight and fast. But when you warm the Arctic and have less of a temperature difference from the equator, you get a wavy and slow jet stream. This slowed-down jet stream is likely causing the stagnant weather systems that prolonged the California drought and kept rain falling for days during Harvey on the same Houston neighborhoods.



Hurricane Michael destroyed close to five billion dollars' worth of homes and businesses, plus almost four billion dollars' worth of crops across Florida and Georgia, including pecan trees and timber that will take a decade or more to recover.

Okay, let's talk about the new IPCC report. Why was it front-page news?

Because it painted the direst picture yet of where we're headed and made clear that 2°C of warming—the longstanding international temperature target—is more dangerous than we thought. There are clear benefits to keeping warming to 1.5°C, which is extremely difficult. Even temporarily overshooting 1.5 °C could have severe impacts on our natural systems, pushing particularly vulnerable ecosystems like coral reefs past tipping points and jeopardizing Earth's biodiversity.

The hopeful news is that staying below that 1.5 °C threshold will significantly ease the danger, sparing millions of people from water scarcity, poverty and sea level rise and reducing the risks of food insecurity, flood, drought, extreme heat, tropical cyclones and the loss of plant and animal species, coral reefs and permafrost.

Right now, we're on pace to hit 1.5°C global warming as early as 2030. Even if all countries fulfill their commitments in the Paris Agreement, the likelihood is very high that we will reach 1.5°C warming by mid-century and remain above this threshold through 2100. So we have to mobilize now at an unprecedented scale—to transform our entire energy sector as well as our farmlands and forests, everything.

It will be particularly important to cut methane, black carbon and other “super-pollutants.” If we don't drastically curb those non-CO2 pollutants, we face a 66 percent likelihood we'll pass the 1.5°C threshold regardless of reductions to carbon dioxide.

Those “super-pollutants” have been the focus of your scientific research; your Princeton PhD was on black carbon. Can you explain their role in climate change?

We often talk about greenhouse gases as a blanket that traps heat on Earth, a blanket we've been thickening as we add more gases to the atmosphere by burning fossil fuels and destroying forests. But our atmosphere is actually more like a patchwork quilt, made up of many gases and particles with very different warming intensities and lifespans. Carbon dioxide is in fact not terribly efficient at trapping heat: it's like a vast, thin bedsheet on the planet. We emit huge quantities year after year, and it can last thousands of years, so those bedsheets are piling up, making CO2 the single biggest contributor to today's warming. But black carbon, or soot, is a million times more powerful in its warming impacts. It disappears in a week, but compared to the CO2 bedsheet, it's a patch a mile thick.



The Trump administration proposes to roll back the Clean Power Plan, undoing all limits on climate pollution from existing coal plants while weakening Clean Air Act protections against deadly soot and smog.

How does understanding those differences among climate pollutants shape EDF's work?

It's really the foundation for our multifront approach to curbing climate change. Understanding how various human activities add to (or draw down) the key warming gases and aerosols—and the damage each will do in ten, fifty, a hundred years and beyond—EDF teams tackle them in turn. We go after deforestation and power plants to rein in CO₂ emissions, fertilizer pollution to reduce nitrous oxide emissions (a patch a little thicker than methane and 10 times more long lasting) and the oil and gas industry to rein in the methane leaks that, combined with other methane emissions from human activities, cause more than 25 percent of the planet's warming. Tackling those emissions often delivers multiple benefits: cutting methane and soot emissions, for instance, improves public health by reducing the air pollutants that exacerbate asthma and other respiratory diseases.

So EDF's climate scientists directly support EDF's work in the world?

Well, we're a small team, at the moment just me and two fellows, though we're hoping to raise sufficient funds to add a second scientist to the team. But yes, all of our research is aimed at understanding the impacts of these various pollutants and how EDF can be most effective in slowing climate change.

Our Kravis post-doctoral fellow, Monika Barcikowska, studies extreme weather, which is hard to do because extreme events are rare and occur at a small spatial scale. The Kravis Scientific Fund provides two years of support for scientists who have recently completed their PhDs so that they can bring cutting-edge new approaches from their dissertation research into organizations like EDF. Monika has worked on global heat waves and winter storms in Europe and right now is looking at how changes in daily low and high temperatures will affect U.S. agriculture, bringing the kinds of unseasonable heat waves and frosts that can wipe out entire crops. That's relevant to the work our Ecosystems team does with ranchers and farmers, helping them to adapt to these extremes and motivating them to keep moving toward practices that reduce their emissions.



Two women in Bangladesh cooking on small coal stoves—these stoves contribute a quarter of the world's black carbon.

I focus mostly on solutions. One of my first projects here was on the cookstoves still used by three billion people, which together contribute a quarter of the world's black carbon: applying my PhD research to a real-world problem. Now I'm working to quantify how much warming we can avoid through realistic measures to reduce methane, using technology available today. We have compelling results that show we could avoid a lot of warming if we went all in on methane mitigation—and that what EDF has done already over the past five years, working with industry and individual companies, will have a big impact moderating future temperatures.

Our High Meadows fellow, Casey Ivanovich, is looking at the warming we are committing ourselves to from our eating patterns worldwide: the impacts of meat, dairy, rice, vegetables, everything. She's working on publishing her startling

findings: that just from eating alone, we will exceed two degrees of warming, unless we change how we both produce and consume food.

Do NGOs typically do this kind of original scientific research?

EDF is the only one I know that puts such an emphasis on publishing papers and staying scientifically relevant. That's something our chief scientist, Steve Hamburg, has really focused on. We even have our own little supercomputer, which Monika has been using to analyze millions of data points, data that thousands of scientists across the world are also analyzing—all part of this IPCC effort to figure out what an additional half a degree of change, from 1.5 to 2 degrees Celsius, will mean for the world.

Ultimately, EDF climate science is pushing toward a larger goal: to move industry and the policy community away from the simplified metrics that everyone uses but do a real disservice to understanding the causes and solutions to climate change—because they put every gas on the same time scale, despite their entirely different properties.

Can you give an example?

Say, for instance, you're trying to compare the impact of eating meat to that of driving your car. Meat contributes to climate change mostly through the emissions from livestock of methane, which in the first twenty years is about 85 times more potent than CO₂. Your car, if it burns gas, produces mostly long-lived CO₂. So if you measure on the 100-year time scale, you capture a fuller picture of your car's impact but hide meat's importance in the near-term. But if you consider only the 20-year time scale, you overlook the long-term impacts of those emissions from your car.

What we need is to use two numbers, like we do for blood pressure, where we all readily understand that neither number on its own gives you a complete picture. For each activity, we need to calculate its impact over 20 years and over 100 years, and report both. It's hard to get industries and governments to change conventions, but since we care about climate change on all time scales, it is critical.

So we're using our science to make that case?

Yes, we're using sophisticated tools to run our own in-house experiments to see how the climate responds over short and long time scales—to changes in the food system, or shipping and aviation, or methane emissions—continuing to build that larger case that time matters.

That's really why I came to EDF—to apply science to real-world issues. I love being able to look around at what my nonscientist EDF colleagues are doing and say, “Hey, we can do science to support that work.” To come from the academic world where I learned fundamental skills but mainly wrote theoretical papers without a clue as to what would happen with my research to an organization where our work is being used every day to make change; where you're with the people who can get it out there to shape the world: that's incredibly rewarding.



Ilissa brought a quilt on stage with her at the Fame Lab finals in May 2016 in Washington, DC Titled “A Patchy Problem,” her talk won her the national championship.

Girls aren't always encouraged to be scientists. Did you face obstacles? Who inspired and encouraged you?

I definitely encountered, and still do, people who don't take me seriously, not only because I'm a woman but because the way I present myself doesn't really jive with most people's idea of a female scientist. So that almost drove me further: I wanted to be a woman in math and science; I wanted to be a female engineer. When at the end of grad school I won an award that's given to just three Princeton graduate students each year, I thought, “Okay, you all doubted me that first year, but I made it.”

Even earlier, my grandpa Martin—my mom's dad—was a big influence. He was a professor of math and mechanical engineering and worked for NASA, developing systems to deflect space debris from the space station. He encouraged and supported me in many ways; he occasionally gave me books from his massive engineering library, which I've now inherited. And in grad school, when the math

got super complicated, he helped me with my homework. He even loved the textbook I hated most—*Geophysical Fluid Dynamics*—so much that he had his local library special order it so he could read it cover to cover. I still have a voicemail from him saved, where he’s saying, “Ilissa, I think we can solve this problem with Cartesian coordinates.” It makes me sad that a lot of my accomplishments have come since he passed away; it’s hard to not be able to share them with the one person who would have truly understood what publishing a paper in *Science* means. To honor him, I recently photographed pages from his grad school notes and screened them onto a blanket, a crazy quilt of triple integrals and intense mathematical expressions.



Record high temperatures in the summer of 2018 caused the oldest and thickest sea ice in the Arctic to break up for the first time on record, opening waters north of Greenland that are normally frozen year-round.

How did you get interested in atmospheric science?

I always thought extreme weather was fascinating, but until I got to the College of Engineering at the University of Michigan, I’d never realized I could study hurricanes or clouds or the sun. Then I heard the head of the Atmospheric, Oceanic and Space Sciences department talk about how he wanted his students to chase tornados or hang-glide into storms with instruments strapped on, so we’d be “one with the atmosphere,” and thought, I’ve found my calling. I eventually realized I was more interested in computer modeling than in field work. I went to Princeton for grad school because it has a world-renowned climate modeling lab and my advisor, V. Ramaswamy, was its director. But I did go to Greenland in 2006 to hike around measuring atmospheric conditions, which changed my life. For the first time, I saw climate change first hand.

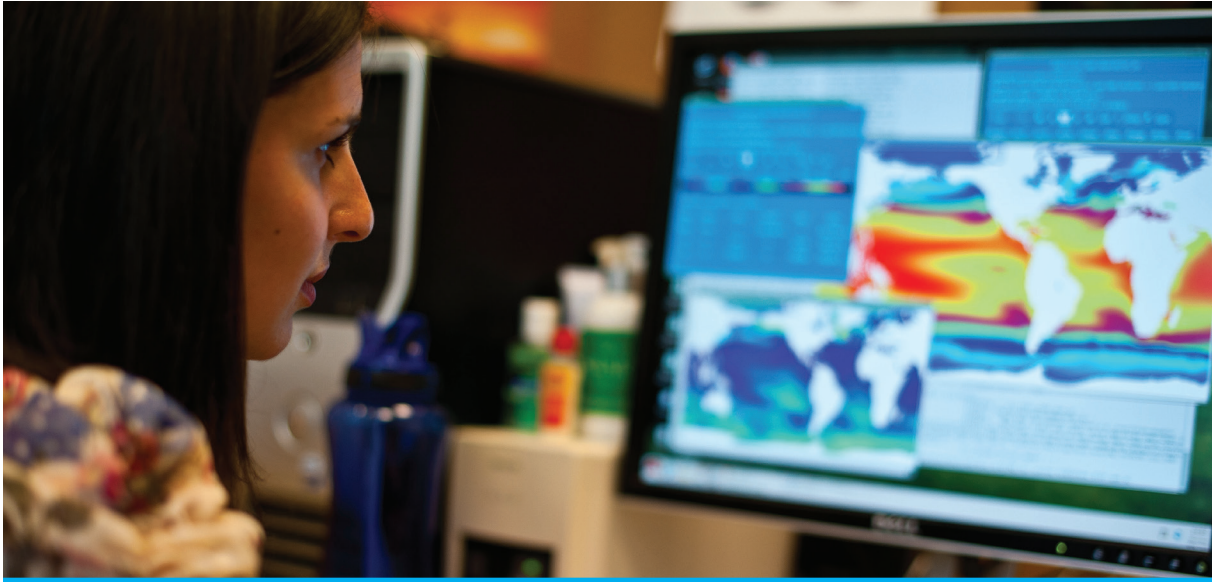
You're a world-class science communicator: you presented your quilt analogy to a group of judges from NASA at FameLab (the *American Idol* for young science communicators) and won the National Championships! When did that interest begin?



Following her first-place win at the National Fame Lab Finals, Ilissa represented the United States at the International Finals in Cheltenham, England, competing against scientists from thirty countries and making it to the final round.

My mom says that when I was five, I told her that I was going to be the weather girl on TV. I soon abandoned that idea, though at Michigan I did work as a weather anchor on the campus television station. But it's always been a dream of mine to be like Bill Nye the Science Guy, the female Bill Nye. I'm super passionate about communicating complex science in plain language and powerful visuals, and an avid designer of science graphics. I am working now to develop a website to aggregate hundreds of credible climate change resources into an easily navigable database, to combat misinformation.

One aspect of my life that has really helped me learn to communicate is my family. I've needed to find a way to share my work with in-laws who for a very long time did not believe in climate change. I've learned so much from that experience about how to talk to people whose perspectives are completely different from mine. I used to get really heated, and that would just push people away. Now I've had a decade of practice in not just talking but listening, hearing what they're saying. If I don't get an argument that's out there, I recognize that it makes sense to someone, so I try hard to understand it.



Ilissa published articles in three peer-reviewed journals based on her analyses of climate model data at the National Oceanic and Atmospheric Administration (NOAA) Geophysical Fluid Dynamics Lab.

So with all these disasters and all you know from your research, how worried are you about our future?

Well, that question is no longer so abstract to me. I'm having a baby in March, my first. So now, when I look at a date like 2040 and whether we'll hit 2 degrees of warming, I think: "That'll be my kid's college graduation."

Since Trump became president, I have had tough moments, because, yes, the science is scary, and it's clear that if we don't act, things are only going to get far worse. And now solutions are being rolled back too.

But I still see so much forward movement and so much energy. My professors' generation was focused on understanding what was going on: Was the climate changing, and if so, why? My generation entered the field of climate science knowing that humans are the cause and grasping the magnitude of the challenge—and feeling driven to solve it. And when you take it apart, what seems an overwhelming problem becomes manageable. You say, as EDF does, "Okay, we've got to tackle these gases from these sectors in this group of countries." Then I know: We can do this.

For more information, please contact EDF member services at 800-684-3322 or email members@edf.org.

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