SW: Ian, you've managed to escape the utter chaos that is twitter, right?

IM: Thoroughly. My only experience is an account I had to make for a class in college that I actually dropped after two weeks.

SW: Then you're missing out on our guest researcher's fun little twitter bio.

IM: what's it say?

SW: "All models are wrong, but some are useful." Turns out it has a double meaning you probably wouldn't expect.

Jane Baldwin: That quote actually has a double meaning for me and I'll get to that in a second. The standard meaning it has is that often, or why I put on my Twitter is that I work a lot with global climate models. And often you hear in the scientific community, people criticize these models as saying, "Well, they have all these biases. How can we believe what they're going to say about the future?" But I guess my attitude is that we should of course be aware of the biases, but we should also see what useful things we can do with models despite these biases. So that's how I'm always approaching my research. The reason why it's kind of an inside joke is because before I seriously began my career as science, I worked as a fashion model for a bit. And so this is for a very small number of people who knew me at that time. They'll see that quote and send me a Twitter message and be like, "Haha, Jane, very funny."

IM: I know we talk a lot about modeling on this podcast, but is there any chance this is going to end with us discussing Fashion Week or at least the Met Gala? I feel like there must be some math involved somewhere…

SW: [laughs] Sadly this episode is going to focus on the non-fashion version of modeling.

IM: Fine. Ok, tell me more about Jane!

SW: Jane Baldwin is an assistant professor of Earth Systems Science at the University of California, Irvine.

IM: And don't forget a former model!

SW: Right, though nowadays she's busy modeling the earth's climate.

IM: I’m sure it looks fabulous on her!

JB: As a scientist feels like there's an infinite number of different questions you could work on that would be really exciting to work on. And figuring out how to prune those ideas so you actually are making forward progress is definitely a big part of the game.

IM: So what questions has Jane narrowed her focus to?

SW: Well, she does a lot of atmospheric climate modeling, but today we’re going to look at one study in particular.

JB: We've developed this Columbia tropical cyclone hazard model, which is basically a way of simulating many, many physically plausible tropical cyclones.

IM: Sounds like this topic is gonna blow me away, buuut, haven’t we forgotten something?

SW: Right, right. Introductions! I’m Sadie Witkowski

IM: and I’m Ian Martin

SW: And you’re listening to Carry the Two, a podcast from the Institute for Mathematical and Statistical Innovation, AKA IMSI.

IM: This is the podcast where Sadie and I talk about the real world applications of mathematical and statistical research. And as a special for the months of May and June, we’ll be narrowing our scope to the mathematics and statistics in the earth sciences.

SW: That’s right! We’re continuing our collaboration with the American Geophysical Union’s podcast, Third Pod from the Sun, titled Solving for Climate.

IM: And if you want to hear Third Pod’s episode, don’t worry, we’ll make sure to link to their podcast in the show notes!

SW: So I first heard about Jane’s research when she presented a talk on “wet bulb temperatures” for IMSI’s Confronting Global Climate Change program.

JB: Basically I had done this work on heat hazards and I increasingly realized that it was pretty difficult to take the work on heat hazards and translate it to some understanding of how that was going to impact people. And so that's resulted in this long-running

collaboration I have with some public health physiology and epidemiology researchers where we're trying to quantify the impacts of heat.

IM: So wait, what is wet bulb temperature?

SW: So you know how a thermometer just tells you how hot or cold it is? Wet bulb temperature is how humidity can affect our perception of temperature and potentially lead to other health hazards.

JB: I think is still an ongoing issue, is epidemiologists think humidity doesn't matter, or at least they find in their studies humidity doesn't matter in assessing heat risks, and physiologists find it really matters. And I think this is very confusing if you're someone like me who's a climate scientist trying to figure out what heat definition to use. So I hope that going into the future, hopefully in five years we will have more of a right answer on that front and so we can be more confident in the definition of heat we're using to think about health impacts.

SW: So that was what her presentation here at IMSI focused on. But today, I want to talk about some of her other work looking at tropical cyclones.

IM: Sounds good, hit me!

JB: to accurately account for risk, you need to know the hazard, the exposure, but also the vulnerability like the fragility of people and structures in the face of that hazard. And that's much harder to get at, especially in less lower income countries that don't have as robust or commonly available census data.

IM: Sooooo, from that quote, it sounds like we're looking at the impacts of climate change abroad.

SW: Correct! We're traveling around the globe to hear about Jane's work on tropical cyclones in the Philippines and how we can understand hazards and vulnerability to these extreme weather events.

JB: I started that work when I was a postdoc at Columbia, and I'm still continuing it now as a professor at University of California Irvine. And we have a pretty good handle on the hazard from tropical cyclones, meaning the physical impacts from these storms, so their wind and how that intersects with human population.

SW: But what's less understood is actual risk.

IM: Isn’t risk and hazard the same thing?

SW: Well like Jane said earlier, to get an accurate measure of risk, you need to know the hazard level, plus the exposure to that hazard, plus vulnerability to the hazard.

IM: Sounds like you just outlined a simple math equation to explain these relationships.

SW: I guess I kind of did!

IM: So I know we get tropical cyclones, AKA hurricanes here in the US, so why was Jane particularly interested in working in the Philippines?

JB: in the U.S. for example, FEMA has an entire hazard vulnerability modeling framework called Hazus, and there really just isn't the equivalent in the Philippines or in a lot of other countries.

SW: So Jane chose to focus on a region that doesn’t often have the benefit of the sophisticated data collection and analysis we have here in the US.

IM: Makes sense if you’re looking to do research with a big impact. But, Sadie, you haven’t actually told me what Jane did for this research….

SW: Right! So, Jane was modeling storm risk of tropical cyclones in the Philippines. To do this, they didn’t have tidy, easy-to-use data like we do in the states. So they had to get a bit inventive.

JB: we ended up basically having to be a little creative about using data on household surveys that our collaborators at the World Bank had to try and get at slightly more regional information about vulnerability. Even though we couldn't necessarily have the high level of spatial detail that might be ideal.

SW: In particular, Jane had to rely on a data set called the LitPop data set to build much of their model.

JB: the LitPop dataset in my tropical cyclone modeling work is what we've used to represent exposure. So basically the distribution of assets across space, LitPop represents it in terms of total dollars, so how much the assets on the ground are worth. And LitPop is clever in that they basically take population data and nightlights data, which is data on lights you can observe at night. And it does a pretty good job of

capturing economic activity basically. So what you can see with the LitPop data set is they've used population density and nightlights data to figure out how to distribute gross levels of assets that they know maybe at the county scale or the regional scale, but they don't know how it should be distributed across space.
And what's cool about this data set is, it's available globally. So we could use it for our work in the Philippines and we could use it if we choose to extend the model to other places.

SW: The name LitPop makes me think of popular literature, but that's clearly not right

IM: I'm pretty sure it stands for population and lights, Sadie. Since it's looking at population density and the amount of manmade light produced at night to get a sense of economic productivity.

SW: Oh my gosh, you're totally right! And that explains the caveat that Jane pointed out when it comes to economic productivity that they can't measure very accurately, namely agriculture.

JB: So you're also talking about what products are created in a place and maybe sold. So basically things that contribute to economic value. So not just homes but also businesses.
I think LitPop does not account for agricultural value. And when storms impact the Philippines, there are definitely agricultural losses that occur
Nightlights data is not going to capture where agricultural products are occurring across the landscape.

IM: wouldn't there be other ways to get information on agriculture? Like, maybe grain export numbers or reported losses after a storm?

SW: That would be one way to look at them, but Jane's group didn't include these since the process gets messy fast.

JB: If you look at the situation reports, so these are reports put out by Philippines emergency services after a tropical cyclone or typhoon has struck, you see a lot of losses coming from agriculture. But I found out later on after I talked to someone who had worked in the Philippines on the ground that those numbers may be fudged basically to ensure they get the payout they're hoping for from the central government. I think agricultural losses might be easier to reimburse than other types of losses.

IM: [laughs] So you don't want to put some potentially fudged numbers into the data. I get it.

SW: Right, better to keep the whole thing simple.

IM: So we've talked a lot about the data Jane used. What were the results of her Philippine study?

SW: I'll tell you, right after this short break.

[ad break - entitled]

[music ends]

IM: Annnnd we're back. So let's hear what Jane found in her study.

SW: Right. As a recap, Jane and her fellow researchers created a model of tropical cyclone risk using open source methods and data. After they created the model, they tested its performance against historical storms on the islands.

IM: How did it do?

SW: So the way the model was built, they could play with the vulnerability parameters a bit and make adjustments.

IM: So dial up or down vulnerability in different regions.

SW: Exactly. And they actually found different vulnerability parameters for Manila as compared to the rest of the region. Probably because there's so much development in that city compared with the rest of the nation. That was finding number one.

IM: What was number two?

SW: The second takeaway is that while the model was pretty good, it did have some cases where, using historical storms, they predicted no losses in a region that was actually quite severely impacted.

IM: So what gives? What's that about?

SW: Well, their model relied solely on wind speed as their metric for hazard.

JB: So tropical cyclones have damages from a few different hazards or sub-perils, you sometimes hear them described as. So there's wind, but then there's also the sometimes extreme rainfall associated with the storms. And then there's also the storm surge, so the flooding that occurs by basically pushing the sea up onto the land. So you can have flooding from that extreme precipitation, but also from this coastal hazard of the ocean or the sea. So this is a huge problem trying to figure out how to model all these different hazards and especially how to model them in the context of a changing climate.
I think the state of the field right now is you're seeing a lot of studies that are looking at compound, sea level rise, and storm surge hazards, and then you're seeing another say that's pushing in the direction of looking at wind and rain.
Hopefully at some point we'll come together and we can model them all at the same time.

IM: So basically, this was a solid first attempt. But we still need to better integrate these hazards when we want to accurately understand vulnerability.

SW: Yeah, there's a need to both integrate more weather variables, and a need to better fine tune the spatial scales used.

IM: So that we can better parse out what's happening in Manila versus a more rural area?

SW: Yeah, or even understand the effects of things like small local changes in elevation that will impact how much vulnerability a region has to a storm.

JB: part of the challenge is the different spatial scales of these different models. So wind as an example, we have reasonable approximations to be able to model wind at relatively broad scales, but if you're getting into really fine spatial details over land, the roughness of the landscape and mountains and textures of different surfaces can impact the wind speed that you're actually experiencing, particularly in the boundary layer. And for a study like I did in the Philippines, those details might matter, but because of how we are calibrating the vulnerability, it wasn't a big deal. But once you start to think about modeling storm surge on top of it, storm surge models, a lot of the best ones are actually very explicitly and dynamically modeling how those parcels of water are being pushed onto the landscape. And as a result you end up with, there generally need to be higher resolution to be able to capture what's going on.

IM: I feel like we just need a big sign or a meme or something that says “NEED MORE DATA”

SW: [laughs] I mean, Jane and her colleagues are able to overcome some of the challenges of limited material, but more would definitely help.

JB: we have some capacity to model each of these components, but whether the spatial and temporal scales are consistent is an issue and whether the fidelity and level of detail of the models is consistent is another issue. And I think we'll be working through that for a little bit, but hopefully can say enough in the short term to say help prepare coastal communities to some degree for this changing hazard.

IM: I love that Jane is really dedicated to working on these problems to try and help the people directly impacted by these tropical cyclones.

SW: I know. Even she stated that she’s driven by a need to actually make a difference in people’s lives.

JB: what I think motivates me to try and understand the climate system better is the hope that someday it will benefit people on the ground. But I also think that a challenge in doing this is sometimes your process for figuring out the right data set or the right person to talk to is going to be quite a bit more meandering than if you're staying in your lane and just working with the hazard data.

IM: It sounds like Jane is someone who's interested in a whole lot of different research questions.

SW: Absolutely. Although it always comes back to a commitment to actually helping people.

JB: I think in the context of the fact that the climate is already changing, that people are trying to figure out how we adapt to it. We need to make some kind of effort to cut across these disciplines so we can actually be modeling the impacts in a rigorous way and not just the hazard. Because a community on the ground, they can't do that much with just knowing how wind is going to increase into the future. They need to know more about the vulnerability and exposure as well. So anyway, that's me on my soapbox a little bit.

SW: In fact, she partially got into climate science research *because* she was dedicated to addressing global warming.

IM: What, was she a campus activist or something?

SW: [laughs] Actually, you hit the nail on the head!

JB: figuring out how contributing as much as I can while also still keeping the fundamental science, which is those fundamental science questions are, [is] why I got into this field in the first place. I didn't talk about this in detail, but I used to be in college, pretty involved in environmental activism and ultimately got out of it, not because I didn't care about [it] but because I thought I was a bad activist. I get very wrapped up in the why's and that really makes me well suited to science.

IM: So someone would be trying to argue with her at a protest about global warming and she'd go into teacher-mode?

SW: Essentially, yeah! Jane is so engaged with understanding the science and process of global climate change that she'd end up focusing on that instead of specific governmental policies.

IM: Oh I get that, my students will often need to pull me out of the weeds.

SW: I do think it's been hard to have been so passionately focused on this area for so much of her life.

JB: when I started grad school, something I liked about my work was that I could open up the New York Times and see something related to climate change. And so it felt the scientific research that I was doing had some relevance to the world around me, and that was motivational. I'd say it's begun to move a little bit from motivational to overwhelming at times. It feels like every time I turn on NPR there's another conversation about some extreme event that's occurred, and they're interviewing an expert who is often someone I maybe know

IM: Would we say this is a 'hazard' of her chosen profession?

SW: I suppose so. And in truth, she's glad to see the media focusing on the changes we're seeing in real time and how they are driven by climate change. Even if the constant climate focus can be personally exhausting to her, it means that others outside her profession are paying more attention. And overall, that's a good thing.

JB: That's just all a way of saying that I think there's going to be this push and pull between the relatively slow pace of science and what feels like this quickly increasing danger, frankly, that we're experiencing from the changing climate system. And I think not just me, but my grad students and the other professors I work with are all grappling with this right now.

IM: So it's a good thing that those of us not studying climate science are grappling with it too.

SW: Yup.

[outro music starts]

SW: Don't forget to check out our show notes in the podcast description for a link to Third Pod from the Sun's story with Jane. We'll also link to Jane's talk on their research from the Confronting Global Climate Change program here at IMSI.

IM: And if you like the show, give us a review on apple podcast or spotify or wherever you listen. By rating and reviewing the show, you really help us spread the word about Carry the Two so that other listeners can discover us.

SW: And for more on the math research being shared at IMSI, be sure to check us out online at our homepage: IMSI dot institute. We're also on twitter at IMSI underscore institute, as well as instagram at IMSI dot institute! That's IMSI, spelled I M S I.

IM: And do you have a burning math question? Maybe you have an idea for a story on how mathematics and statistics connect with the world around us. Send us an email with your idea!

SW: You can send your feedback, ideas, and more to sadiewit AT IMSI dot institute. That's S A D I E W I T at I M S I dot institute.

IM: We'd also like to thank our audio engineer, Tyler Damme for his production on the show.

SW: And thanks to Devin Reese, producer with AGU's Third Pod from the Sun for their work collecting tape.

IM: And music is from Blue Dot Sessions.

SW: Lastly, Carry the Two is made possible by the Institute for Mathematical and Statistical Innovation, located on the gorgeous campus of the University of Chicago. We are supported by the National Science Foundation and the University of Chicago.