Steve Quiring Keeps an Eye on Temperatures Across the Globe

Tue, Oct 17, 2023 12:08PM 26:15

SUMMARY KEYWORDS

climatologist, drought, work, predictability, forecast, weather, climate, system, research, storm, atmosphere, skill, ohio, predict, oceans, project, place, models, ocean temperatures, surface

SPEAKERS

Eva Dale, Steve Quiring, David Staley

E Eva Dale 00:00

From the heart of the Ohio State University on the Oval, this is Voices of Excellence from the College of Arts and Sciences with your host, David Staley. Voices focuses on the innovative work being done by faculty and staff in the College of Arts and Sciences at The Ohio State University. From departments as wide ranging as art, astronomy, chemistry and biochemistry, physics, emergent materials, mathematics, and languages, among many others, the college always has something great happening. Join us to find out what's new now.

D David Staley 00:31

Steven Quiring is a Professor of Atmospheric Sciences in the Department of Geography at The Ohio State University, College of Arts and Sciences. He earned his bachelor's and master's degree at the University of Manitoba and his Doctorate in Climatology at the University of Delaware. He is the recipient of a National Science Foundation Career Award for his work with drought predictability and the role of land atmosphere interactions in the U.S. Great Plains. He joined the faculty of Ohio State in 2016, and welcome to Voices from Arts and Sciences, Dr. Quiring.

S Steve Quiring 00:50

Good morning, and welcome to you.

D David Staley 01:05

Thank you. So, let's start with drought predictability. So I think of droughts as like, complex adaptive systems. Are droughts actually predictable?

S Steve Quiring 01:17

So there is aspects of droughts that are predictable, and that's really what I'm interested in trying to figure out is, where, and when, and which ones can be predicted.

D David Staley 01:28

Okay.

S Steve Quiring 01:29

And so, when we... there are places on the surface of the Earth - hotspots - and these hotspots are places where, typically when we think about the climate system, there's really two sources of memory, two sources of predictability in the climate system. The first and most important is the oceans, and so things like El NiÃ±o, the Pacific Decadal Oscillation.

D David Staley 01:52

Which is?

S Steve Quiring 01:54

So, El NiÃ±o represents warmer and the normal sea surface temperatures in the eastern equatorial Pacific, and there's an opposite phase La NiÃ±a, which is colder than normal sea surface temperatures. And because of where these areas of change occur in ocean temperatures, it actually drives atmospheric circulation, it changes evaporation and precipitation patterns, and not just locally, in the Pacific, but globally. And there are other places where changes in ocean temperatures and ocean circulation also influence the climate, and these can occur on relatively short timescales, so kind of seasonal, to inter-annual, but other ocean patterns are decadal, or multi-decadal. So this is the primary place we look in terms of memory and predictability in the climate system, because we can see how past events have caused droughts to occur, and these are naturally occurring oscillations of ocean temperatures that have been attributed to the fall of previous civilizations hundreds or thousands of years before, as well as causing major impacts in terms of droughts. So that's one source. The other source is the, is the land surface itself. And the land surface, this is the primary place that I'm focusing on, it is less important in terms of the overall contribution. So we might think of the oceans as 70% of the predictability and the land surface about 30%. But in some places, and at some times the land surface plays a dominant role. And this is because all the solar radiation that enters the atmosphere, the atmosphere is relatively transparent, we have clouds that reflect things, but a lot of the energy reaches the surface, and when it does, it is either heating up the surface, sensible heat, or it's evaporating water, latent heat. And so, based on how much water is available at the surface, what the surface is like, is there vegetation, is there moisture in the soil, that changes the lower atmosphere, and it can perpetuate, initiate and perpetuate drought conditions.

D

David Staley 04:15

Are we able to sort of pinpoint predictions about droughts? In other words, could you make a statement about the possibility of drought in central Ohio?

S

Steve Quiring 04:25

Yes, so we do -

D

David Staley 04:27

You hemmed it a little bit there, so.

S

Steve Quiring 04:29

Predicting drought is kind of the Holy Grail, so it is very difficult to do accurately. There is skill, but that skill is relatively modest. So think about, for example, the skill of predicting precipitation three days from now, or seven days from now, or ten days from now. So if you have a big event coming up, you're having a bunch of people over for grilling out in your backyard, and you want to know is it gonna rain that afternoon or not, and you're preparing a week week or two in advance, there's some skill in numerical weather prediction models, but there's a predictability barrier. So when we're looking at droughts and trying to predict a season or a year in advance, we're actually using different processes, not explicit numerical weather prediction models that solve the atmosphere and ocean dynamics and exchanges of energy, we're using, we're looking at the sources of predictability and often using statistical approaches to say, oh, there's a strong El NiÃ±o, oh, the Pacific, North Pacific sea surface temperatures are colder than normal, oh, look at the sea ice concentration in the Arctic. And so these sources of memory in the climate system that act on these longer timescales can kind of load the dice and tell us that there's a greater probability of a dry summer in Ohio, for example.

D

David Staley 05:56

Well, that's what I was gonna say. So that when I'm trying to figure out what the weather is going to look like, ten days from now, in preparation for my barbecue, it's usually presented to me as a probability, that there's a 40% chance of rain - do you do something similar when you're thinking about droughts, there's a 40%, or a 50% chance of drought?

S

Steve Quiring 06:15

Right, so when we're thinking about making drought forecasts, or any kind of seasonal climate forecast, and so the Climate Prediction Center, routinely issues monthly, seasonal and annual climate predictions, and those would say, we think temperatures this summer or next fall are going to be above normal, near normal, or below normal. So they use these turnstiles, these three bins, and so it's not saying the average temperature in Ohio this summer is going to be

82 degrees. It's saying the temperatures in Ohio this summer are going to be near normal. Same thing with drought, we would kind of say, is it going to be near normal precipitation, above normal, a wet summer, or below normal dry conditions? And so, that's the first way that things get hedged, I guess. And then there are also probabilities to say, given past years, when this similar setup existed, how many times did a drought occur? And so that gives you odds that you can use to, if you assume that the climate is stationary.

D

David Staley 07:26

You used the term a few minutes ago, predictability barrier, tell us tell us what the predictability barrier is, and why there's a barrier.

S

Steve Quiring 07:34

Sure. So, in the climate system, because of chaos, there is... if we knew initial conditions perfectly, we would greatly improve the predictability and forecasts, but because there's uncertainty in knowing initial conditions, we don't know, the temperature of the atmosphere everywhere, we don't know the temperature of the land surface everywhere, we don't know exactly how many grams of water are in the atmosphere at each point over the entire Earth's surface. And so as we run our calculations, numerical weather prediction models, our atmospheric physics, and so, as we run these equations, we, that uncertainty intensifies the further out we go, and so most reputable weather forecasts are 10 days or 14 days at the most. And at that point, there is very little skill. If we compare how accurate those are versus just a random guess, or climatology, we, we can't really beat that. So that predictability barrier is, is because of the lack of knowledge of initial conditions, and also the ability of computer models to resolve all of the processes that are important in the climate system, which take place from, at scales of hundreths of an inch to thousands of miles. And as a result, getting all of that accurately represented in a computer model and calculated at a defined enough resolution in space and time means we don't, we won't ever perfectly predict things.

D

David Staley 09:16

So it sounds like you use a lot of modeling in your work, and I know that some of the work that you're doing involves modeling the impact of weather events on power infrastructure. Tell us a little bit more about that and how you got into that, that area of research.

S

Steve Quiring 09:32

Yeah, so I would consider myself someone who is an applied climatologist or works with weather data analytics. And the exciting part of this is that it's very interdisciplinary. And so, rather than just studying the climate system or the atmosphere, it's looking at the impacts of weather and climate on various systems. And one of those is, is the power system. So this was something that, being a faculty member at a university, you get to interact with a lot of really smart people who have work in fields very different than your own.

D David Staley 10:06

Such as?

S Steve Quiring 10:07

Such as Seth Guikema, who was a Civil Engineering Professor, that I sat next to at a new faculty orientation when I started at Texas A&M University. And since that time, over the last about 12 plus years, he had this, we've worked on power systems, because that was a data set and a problem that he had, he didn't have knowledge of the climate system. And so we've grown this to work both with the Department of Energy, to work with local utilities, we're currently working with ADP and First Energy, and so, they're very interested in improving reliability of their system, reducing the duration of outages, and reducing the number of outages. And so they take a number of, they make a number of decisions pre-storm and post-storm to try and restore your power as quickly as possible. And so in this case, the primary cause of major power disruptions in the United States is weather. And that is, thunderstorms -

D David Staley 11:14

You live in central Ohio, we know all about that, right? Thunderstorms and those sorts of things ending our power.

S Steve Quiring 11:19

Yes. And in fact, Ohio, in terms of rank is the state with the third highest number of power outages over the last decade. So weather is a significant issue and in Ohio, and something that utilities in Ohio are very concerned with, and that in fact, there's some regulatory oversight that encourages them to be responsive and be proactive in preparing for and hardening their system to reduce the number of these outages that occur. And we're using weather information, weather forecasts to help them make better decisions about that. Where will people lose power, how long will they be out for, and how big will particular forecast storm be? Is this going to be a small number of outages that they can handle with their internal resources, or do they need to band together through mutual aid with other utilities from neighboring regions that maybe aren't affected by a particular storm, and bring in those people to help? And this is especially the case with really large events, so derechos or a winter storm with a lot of ice or those kinds of things that may exceed their ability to respond.

D David Staley 12:38

So are you, in effect, making sort of annual forecasts for them? Are you letting them know, since we're coming up on the storm season, are you sort of saying here are the probabilities for this number, and this sort of an intensity of storms this summer?

S Steve Quiring 12:51

So the timescales that we mostly work at are based on their operational decision making. So, we are forecasting weather related impacts on daily timescale, so we're -

D David Staley 13:03

Daily? Okay.

S Steve Quiring 13:04

So we're using the weather forecast for the next five days, for example, in forecasting the, the probability and number of weather-related outages in each one of their districts on a, on a daily timestep.

D David Staley 13:21

And, well, what can you tell us about this summer?

S Steve Quiring 13:25

The conditions this summer are, as usual, difficult to predict. There's, there's not a lot that I can say about the specifics of what to expect in the state of Ohio. Things are trending a little bit drier, currently, in the western part of the state on kind of short timescales, but obviously, it was a relatively wet winter, so if we think about persistence, climatology and persistence, we would say that the climatological forecast would be near normal.

D David Staley 14:00

Well, I appreciate that answer. I put you on the spot a little bit there, and I appreciate, appreciate your very nuanced answer there. So you are a climatologist, and of course there are huge debates today about about climate change, about the status of climate change, especially at policy levels and national government decision making policy levels. How do you react to the public debate that we're having about climate change, and in particular, those who deny both climate change and sort of man-made climate change? As a climatologist, how do you respond or react to this debate?

S Steve Quiring 14:37

Sure, this is an important question and one that is one of the central things that I think as a climatologist, we need to do a better job of communicating with policymakers and with the public. From a scientific perspective, the science is very certain and very settled and reviews of the scientific literature suggests that 97 to 98 percent of climatologists who have graduate training in this, study it, are in agreement that humans are having a large impact on the climate system through greenhouse gas emissions. In the United States, and in other places around the world, there are facets that are concerned or that are less convinced, I guess, about why and how this is happening. And so the best way to approach it is to use things, concrete examples that are at hand. And so we can take, in the United States, recent events like Hurricane Harvey. And Hurricane Harvey, it was not caused by climate change, but the impacts of Hurricane Harvey were exacerbated by climate change.

D David Staley 15:49

In what ways?

S Steve Quiring 15:50

So as we look at a warming world, there's two important things that happen that affect hurricanes. The first is the warming of the oceans themselves. And so, sea surface temperatures and warm oceans, because of the evaporation, that's the fuel for tropical cyclones, for hurricanes.

D David Staley 16:09

Like pouring gasoline on a fire.

S Steve Quiring 16:10

Yeah, and so the warmer the ocean gets, all else being equal, the more intense the storms are going to be. And that's an example with Harvey. The second thing is, when we think about a warming world, we also talk about an intensified hydrologic cycle. So more rainfall, and more intense rainfall. And that's one of the primary causes of the loss of life, the economic losses, the extreme flooding in Houston was just the amount of rainfall that it generated, record setting rainfall amounts. And this again, we can't say is solely due to anthropogenic climate change. But -

D David Staley 16:50

Anthropogenic meaning manmade?

S Steve Quiring 16:52

Yes, human caused.

D David Staley 16:54

Human influenced.

S

Steve Quiring 16:55

Human influenced. But, these types of storms are more likely, we're shifting the odds to say that a Hurricane Harvey-like storm will not be a one in 500 year event. But more like a one in 50 year event in the future as we continue to warm the oceans, warm the atmosphere, and allow for that stronger storms and wetter tropical cyclones to occur.

D

David Staley 17:23

Tell us about your lab and, you know, the equipment we'd see in it the personnel, the way knowledge is organized in your lab.

S

Steve Quiring 17:32

Yeah, so I have eight graduate students, two postdoctoral research associates, and two undergraduate students who work in my lab at Ohio State. And, it's a really dynamic place, because of all the different projects, and the, all the different backgrounds that the students are working on. The way that things are kind of organized is that I have, I'm always looking to hire undergraduate students and get them, their feet wet, get them in the door, to work with data. And they are paired with a graduate student, or with one of the postdocs who kind of helps mentor them through. So currently, I have two students, one's working on a NASA funded project. And so he's looking at a really long record of lightning data this summer, or, and so his summer research project, we have lightning data, every lightning strike in the United States from 2005 through 2016.

D

David Staley 18:30

Wow, every one.

S

Steve Quiring 18:31

In one single year, for example, there were 169 million lightning strikes recorded in this dataset. So it's a very large data set, and it requires coding skills to really slice and dice and analyze. And so that's, we're just throwing him into that and giving him a chance to work with it

D

David Staley 18:53

And this is one of your graduate students you say, that's working on this.

S

Steve Quiring 18:56

This is an undergraduate student.

D David Staley 18:56

An undergraduate is working on this?

S Steve Quiring 18:59

Yeah, paired with some graduate students. But this is a dataset that we acquired as part of this NASA project. We hadn't had a chance to work with it yet. And this was a student who was in my class.

D David Staley 19:11

How common is that to have undergraduates working on such a project like that? It seems like a tremendous opportunity for an undergrad.

S Steve Quiring 19:18

Yeah, what really started this for me was the NSF Career Award. And for that, they want you to have a compelling education component to it. And what I did was to teach a first year seminar, use that first year seminar to recruit students into my lab, and then to have them involved in the project so that they would start, maybe the summer of their freshman year, and continue all the way through. So one of the challenges is that undergraduate students, we want them to graduate in a timely fashion and move on. And often they don't start research until they're a junior or senior, and so you have a limited amount of time to work. with them, they have lots of classes and other things. And so, kind of flipping it and picking them up right at the beginning of their career at the university, they may have less subject specialist expertise, but they have a longer period of time. And so we pair them with graduate students and postdocs who have skills and knowledge. And we work to grow their knowledge base and their skill set throughout the entire four years that they're here.

D David Staley 20:29

Because I know in those freshman year classes, I mean, they're not necessarily Geography majors, they either come in with other majors or minor, maybe no majors. And so you're taking, you're taking quite a risk, I suppose, in being able to what cultivate future climatologists?

S Steve Quiring 20:45

And, it's not really a risk, it's just an giving them an opportunity to see if they are interested in it. And absolutely, there is some attrition along the way, as students realize, hey, this sounded a lot more exciting than sitting in front of a computer for 20 hours a week writing code. But, a lot of them do appreciate the opportunity and the insights into how research works. And it's been a very excellent way to connect with students and not all of them go on, I'm not trying to replicate myself for, have a bunch of mini climatologists running around, a lot of them go on to work in other areas. But I think the critical thinking, problem solving, communication in a diverse team, all of those things are lifelong skills that, regardless of whether you're a climatologist or an account manager for Nationwide, you need some of those skills.

D David Staley 21:42

That's a, that's a great example of this nexus between research and teaching. I think that defines what we do, what we do at Ohio State. Your, your role as director of the lab, give us a sense of what the director does. I mean, obviously, you have students that are coding and are doing a lot of the research, what's your role as the director?

S Steve Quiring 22:01

Yeah, so my role as the director is to keep all the balls in the air. And -

D David Staley 22:08

Tell us about what those balls are?

S Steve Quiring 22:10

Sure. So, on a day to day basis, I have research meetings to keep up to date on the projects, I'm communicating with my collaborators at other universities to coordinate the research tasks that are taking place here, versus the ones that are taking place at other universities around the country, around the world. The organization is a big part of it. And fundraising, honestly, is a big part of it. So to support ten full-time people, you probably need eight to ten projects. And so most of, a lot of my time is spent on writing proposals, going to meetings, and presenting. For NASA, for example, they have Principal Investigator meetings where they bring together all the people funded under a particular program, and you share results and learn from what others are doing. It's also a great place to get new ideas, and to find new collaborators where you can say, wow, what you're doing, I never thought of that before, really intersects nicely with my project, why don't we talk about other opportunities? So, as director, I wear a lot of different hats, I do less of the, in the lab, data analysis and more of the big picture, organization direction, communication, and especially fundraising.

D David Staley 23:37

So what are your next research interests or goals? What's next after working with weather events on power infrastructure, or drought predictability? What's next on your research horizon?

S Steve Quiring 23:48

Sure. So there's two things I'm particularly excited about. One builds from the power outage work that we're doing, and that is developing a model that can be applied globally. And so one of the big limitations is data. And, so, we're looking for ways that we can leverage, especially satellite products that are available globally. And because hurricanes are a global threat, and hurricane related power outages cause significant disruptions to the economy and loss of life, we're interested in developing these models in Southeast Asia, in India, and in other parts of the world that are affected by, the not call them hurricanes, they may call them typhoons, and but we have some partnerships that we've developed now in places that allow us to get some datasets and also to leverage global satellites from NASA. So that's one, the other is looking at health related impacts. So, as I mentioned, as an applied climatologist, I'm very interested in looking at weather and climate impacts, and putting those together with other areas and in Ohio, for example, harmful algal blooms are a big deal. And so, we have a pending project, which is with colleagues in Earth science and a medical geographer in my department that look at the health impacts of harmful algal blooms in the communities that surround Lake Erie. So, being able to forecast what those health impacts are. There's forecasts for the HABs themselves but not looking at the connections between, as the water quality changes in Lake Erie, what does that mean for atmospheric circulation? What does that mean for drinking water? Are their increased respiratory illnesses? How far inland do those propagate? How to weather conditions influence that? And so, that's a way that weather and climate information can be used to improve people's quality of life and hopefully to prevent harm to folks who are susceptible.

D

David Staley 25:57

Steven Quiring. Thank you.

S

Steve Quiring 26:00

Thank you very much.

E

Eva Dale 26:01

Voices is produced and recorded at the Ohio State University College of Arts and Sciences Technology Services Studio. Sound engineering by Paul Kotheimer, produced by Doug Dangler.