Ep. 16 Recipe for disaster: hurricane

Jonathan 0:00
According to recent reports, South Carolina is home to seven of the top twenty most hurricane-vulnerable counties. In order of vulnerability, they include Charleston, Horry, Beaufort, Berkeley and Dorchester counties, with Charleston and Horry counties ranking third and fourth nationally, respectively.

There are many factors that go into hurricane frequency and strength. They include ocean temperature, atmospheric temperature, air moisture, and wind speed and direction. Other factors are the El Nino Southern Oscillation, known as ENSO, and Atlantic Multidecadal Oscillation, known as AMO.

Today on Earthly, I interview Prakash Khedun. Khedun is a Clemson University climate resilience specialist.

He is going to prime us for hurricane season by helping us better understand some of the weather elements that influence the frequency and power of these storms.

Prakash 1:29
Thank you for having me. Now, indeed, hurricanes along with tornadoes, they're like some of the worst devastating events that we experience depending where they make landfall. You know, that determines the extent of the damage. These could be major infrastructural damage and sometimes there's loss of life. Now, a hurricane, it starts as a weather disturbance in the ocean, a tropical wave, which is a low-pressure area. This is often in the tropics where the water is warmer. And as this disturbance move over the warm ocean, the warm air rises, and it forms a storm. And this creates an area of low-pressure and more is being now transported upward. This warm moisture, rich air, it cools as it rises and forms clouds and thunderstorms. They have a system that is in place that starts to kind of feed into itself, becoming stronger and stronger. This warm, moist air and that acts as the fuel and helps this system grow. There is also wind activity happening at the same time. There's strong wind activity in the system is as this air rises, the wind begins to blow in a circle spiraling upward when the wind speed reaches 74 miles per hour. This is when we name it as a hurricane.

Jonathan 2:51
Can we conclude from that that the more time a hurricane spends over the water, the more powerful it becomes? So slow moving hurricanes can become more powerful.

Prakash 3:01
Definitely slow-moving hurricane gives, you know, it has more time for the system to grow and collects more moisture and the wind activity becomes stronger. So indeed, slow moving hurricanes can become a stronger.

Jonathan 3:17
So, let's break down the hurricane ingredients. I know it takes all of them to create a hurricane, but which are the most important factors in hurricane strength?

Prakash 3:26
So first you need this disturbance to start the process. Then you need to have a warm ocean because this is what provides the fuel to help the system grow. And of course, there should be strong winds. The stronger, the more damage it will cause once it makes landfall. The wind speed is an important indicator. So, no uses a wind speed to determine the hurricane category. So, we have if it's between 74 to 95 miles per hour, you would have a category one hurricane. If it's between 96 and 110 miles per hour. You would have a category two and so on. And it goes up to a Category five where you have a wind speed that is above 155 miles per hour. Now, sometimes you can have a system that's been that's that doesn't necessarily need to be strong on the category like in scale, but it still causes tremendous damage. I take the example of Hurricane Harvey, which made landfall in Texas in Louisiana on August 27, 2017. It was a Category four hurricane and it caused over 100 billion in damages, mostly due to flooding in the Houston area. When the hurricane made landfall. It we it had weakened, but it stalled just inland. And it was at the right place, and it was able to pump water from the ocean and dump it inland. And in that process, over a couple of days, 3 trillion gallons of rain fell over the Gulf area, which includes Houston and other metropolitan areas.

Jonathan 5:08
30. 4 million gallons of water. with Harvey, was it like part of it was it got stalled by that you mean part of it got caught over the ocean and part of it was over the land.

Prakash 5:19
So, it made landfall, and it was just sitting there. If it had if it kept moving, you know, so once a hurricane moves inland, it starts losing energy because there's no warm water, there's nothing to feed it. So that's where it starts. So, all that, all that clouds and everything that it's been carrying so slowly dissipates as it rains overland. But in this case, it just it just sat there. It stalled and it was a perfect system to pump the water and dump it and pump and dump it. I mean, I was in Texas at that time, and I mean, I was not in Houston, but I was just to always 2 hours away from Houston. And it rain like crazy. And I mean, I've lived like 15 years in Texas. I've never seen it rain like that. And it rained over days. We would see pictures in the news and yeah, 33 trillion gallon. And Houston, you know, the thing is not every city has the infrastructure to really contain and channel this water out quickly. And Houston cannot do it. 33 trillion gallons of water over two days is a lot. So, you know, the devastation that's caused by a hurricane is very much dependent on where it makes landfall. Right in the United States. Luckily, you know, we don't have as much loss of lives. But in other parts of the world, you know, we're in the Indian Ocean where we call it a cyclone. It's it can be it can be really, really bad. You know, it decimates your infrastructure. There's flooding. It affects your infrastructure, you know, electricity and so on. But it also affects your crops

Jonathan 6:55
I'm sure that goes back to the idea that, coastal communities have building codes in the United States, and they're required to follow those building codes. And that has helped, I'm sure, reduce the number of fatalities.

Prakash 7:09
Yes, the building codes are very important, but houses in the United States are not designed to withstand such winds. So, I come from a tropical island. I've seen cyclones, but I was in a house that was made out of concrete. My house, I didn't lose my house. But in in the United States, after a hurricane in Florida, you see you see major devastation. one thing that we do really well in the United States is these evacuation routes. And that's extremely important. You know, these evacuation routes are really, really important. You know, we have a robust warning system. If people listen to those warning systems and start taking precaution, when we tell them to start taking these precautions or start moving out of an area, that is what saves lives and keeping those roads clear or making sure that there is the traffic and flows help people move out. That is extremely important.

Jonathan 8:05
Okay. there is this thing, it's called the El Nino Southern Oscillation, or it's also known as Enzo. What is it and how does it impact weather volatility and hurricanes?

Prakash 8:18
So, ENSO is an acronym. It stands for this for El Nino Southern Oscillation. It's a coupled ocean atmosphere phenomenon in the news. We often hear about El Nino and sometimes its counterpart, which is La Nina. The last El Nino just ended. It started like last summer and recently came to an end. We are in a neutral phase, and we are expecting a La Nina soon. What we've seen in the past is so first I need to add that this is an irregular pattern. It happens between anywhere between two and seven years and once we have an El Nino, it can last for 1 to 2 years. We've had some that are short duration, very strong, some are longer duration, but not as strong. And their effects are different in 1982 83, for example, we had an El Nino. We saw droughts in wildfires in Australia, we saw droughts in sub-Saharan Africa. At the same time, we're seeing flooding in southern Ecuador. In northern Peru, rivers were carrying over a thousand times their normal flow again in the night in 1997 98, we had another El Nino. It caused flooding in California. We had random twisters, which we think are probably linked to a change in the jet stream. We had forest fires in Indonesia, we had drought in Mexico. So, when these phenomena happens, they really cause weather havoc around the world and different regions, experience different times, different types of weather have it. So, this summer we were expecting a La Nina. So, what we've seen in the past is La Nina Summers that follows strong El Ninos. They tend to be some of the hottest in the US and it looks like this particular summer is not going to be any different. NOAA's summer outlook already predicts that a very high probability of warmer than usual summer, hot summer means, you know, higher, stronger possibility of drought. And as an area dries

out, not enough rainfall, it gets warmer, the sun's energy further dries the ground. And because there's no vegetation and soil moisture, so the drought becomes worse. We've also seen enhanced cyclonic activity in the Atlantic. During La Nina, a warmer Atlantic Ocean would be the perfect, perfect recipe for more hurricanes. And conditions may be such that these hurricanes, meaning they are longer and become stronger. So that's what we may expect

Jonathan 11:00
you mentioned the El Nino that just ended was pretty short. It lasted a year. Does that mean it was more powerful, like, ah, with the shorter or the more powerful?

Prakash 11:09
Not necessarily. Now, I've looked in my work, I've looked at compare different El Ninos. You know, you can be the one to the other. It just summer tend to be short but strong. But that doesn't mean that all short duration El Ninos are stronger ones. So sometimes you have El Nino that falls and then you have a feeling that it's going to die. And then there's another one. It spikes again. So, all these are measured from we know we have an El Nino based on measurements of sea surface temperature. So that's the that's the indicator that we use.

Jonathan 11:41
What what's the temperature that determines if it's an El Nino?

Prakash 11:45
So, we do, and we take the actual temperature, and you subtract the mean, and you have an anomaly. And this anomaly now is going to be centered around the mean of zero. And then you have positives and negatives. And if you have if it if it's above 0.5 degrees Celsius for more than three months, then we know we have an El Nino.

Jonathan 12:08
So now there's another weather pattern. It's ammo. It's the Atlantic Multidecadal Oscillation. I'm guessing from its name that it is a more longer-range weather pattern. Tell us tell us about that one.

Prakash 12:21
So, the Atlantic multidecadal oscillation is is just one of the many natural climate variability patterns out there. They'll be the other long range. They last longer they are. And this one it is or we detected in the northern Atlantic Ocean it has a cycle of 20 to 40 years at a time, so can be 40 years in the positive phase and then 4020 to 40 years in the negative phase. There are other such phenomena out there, like the PDO, the Pacific Decadal Oscillation, or the Indian Ocean Dipole Nino, according to where we where they occur or where we measure them. So, when the air moves in the warm phase, we've seen that there is there are a greater number of tropical storms that forms and matures into hurricanes. So that is also a contributor to enhanced hurricane activity.

Jonathan 13:15
there's also another phenomenon called tele connection. What is it and how does it work?

Prakash 13:20
So, these climate variability patterns that we've that we've talked about, the particularly rockery in the ocean, this is where we are measuring sea surface temperature and they are fluctuations and this is how we determine whether we are, for example, positive phase and El Nino or negative phase La Nina and or positive AMU and etc.. So, they are coupled ocean atmosphere phenomenon and so which means that they have an atmospheric signature and now the whole weather system is connected. Whatever happens in the ocean affects what we experience on land. you take ENSO for example; we've seen that the weather deviates dramatically from what we would normally experience. Have we been in a in a neutral condition when we were when we are experiencing either an El Nino or La Nina and these changes, they are not consistent across the globe. One region may be experiencing cooler temperature during an El Nino and another ESE region may be experiencing a severe drought.

Jonathan 14:22
So, Prakash, going back to the idea of the hurricane recipe and the ingredients that create a hurricane, how do these weather patterns and Enzo and ammo create the ingredients of storms?

Prakash 14:38
So that's a great question. So, let's take the La Nina condition, for example. So, no upward is predicting that there is a over 80% chance that this because of La Nina, the hurricane season is going to be above normal, that we it's going to be summer. We still have all the major ingredients for hurricane. But with La Nina as opposed to neutral conditions, we will have a warmer Atlantic Ocean, which is conducive to stronger hurricanes. On a more like technical level, you have this vertical wind shear, which is basically a wind speed and direction above, above ground, height, above ground. If you have strong vertical wind shear, it dampens hurricanes and sometimes it even suppress them. But in the Atlantic basin, this happens during an El Nino and in La Nina to the reverse. So, with La Nina happening and with Summer, so we're definitely going to have an enhanced hurricane activity in other basins. It's it could be the opposite condition and it changes from one ocean to the other.

Jonathan 15:47
History tells us that hurricane frequency and hurricane strength has been increasing over the years. Talk about what we know about why this is happening.

Prakash 15:57
So, far, we've been we've talked about these natural climate variability. Now there is also climate change, which further increases the complexity. In a nutshell, with climate change, we are experiencing a shift towards warmer temperatures, which means our winters is

going to be warmer and they can also be shorter than what we've experienced in the past. We will have

warmer, hotter summers. We've already seen it in places like Texas last summer. You know, while we don't directly attribute one event to climate change, but every indication, you know, climate models and every indication is pointing to what those climate models have been predicting and warning us against. So, this summer is going to be warmer, of course, and that's because of La Nina. But at the same time, climate change activity is going to contribute and help make things worse. Warmer temperatures means warmer ocean, therefore, more energy for hurricanes to form and strengthen.

Jonathan 17:04
We want our listeners to pay very close attention to the weather reporting and to always heed warnings from officials. But if our listeners wanted to play like amateur meteorologists and predict a strong or weak hurricane season, what data do you think they should pay the closest attention to?

Prakash 17:23
So I would say that on top of what they have already been doing, they should pay attention to the phase of these Climategate connection patterns. And so in particular, of course, they can also look at the others like ammo and pedo depending on where they are. You know, a simple Google search will take them to the NOAA's website, where they can look at the time series. If they want, they can even download it and play with this data. So, they would see which phase we are in, and they can consult the literature and tell them, you know, how it is when we are in these different phases, what to expect. Now, over the years, you know, these prediction for these climate election and elimination patterns have gotten better. And every day we're learning more on how they interact and how they affect the weather and other environmental conditions across the world. I would say, you know, it's also important to bear in mind that the impacts are not the same. It's that's very important. You know, what we see on the East Coast will be different from what we will experience on the West Coast. And this would be, again, different on other continents like Africa, Australia, Asia. So, it just changes from place to place. And some places have stronger connection and others don't.

Jonathan 18:41
before we go, I want you to tell us about the South Carolina Water Resources Center here at Clemson and what kinds of things are being studied there.

Prakash 18:50
So, the water center is a is a unit within Clemson University. It serves as a liaison between the USGS and the water agencies within the state. It is one of the 54 institutes that we have in the country, and they are working under the aegis of the National Institute for Water Resources. It's a vital link between academia and not just talking about just Clemson universities, but all the other universities in the state and the various water agencies and then state legislature, legislators and policymakers. So, the work that we do and through

this, the water center, it helps translate like research into policies. So that we have evidence-based policies for the benefit of the residents of the state of South Carolina.

Jonathan 19:36
You mentioned we're getting better at predicting the impacts of these Tesla connections. Can you describe how it is and why it is we're getting better at that.

Prakash 19:48
So, it took us a while. It took scientists a while to understand actually what these climate election telecon action patterns really are. But we are getting better because we have better monitoring stations. We have buoys in the ocean. We have satellites collecting data, we don't have just regional data, but we have global data that helps us really understand how these patterns are forming and how they affect conditions elsewhere and over time, because El Nino and so has we've realized that it is such an important phenomenon. You know, there's a lot of scientists working on trying to predict they've built different type of models, including like statistical models, to try to predict, you know, so these are all probabilistic prediction. You know, what is the probability of having an El Nino next year based on all the other conditions? So, it takes in quite a lot of data that we collect around the world, and that's how we are able to make those predictions.

Jonathan 20:47
who's collecting this data and how is it being shared? Is it just open to scientists like you to use interpret?

Prakash 20:55
Yes. So, there is there's no Lassa in the United States. These are the two major agencies collecting this data. Across the world there all European agencies, Australian agencies in Asia, there's India, Japan. They've got the various monitoring stations. And sharing the data is really important. You see that's really, really important. So other countries are sharing the data, and we have this this data available. And honestly, I just go in and download it from NOAA's website and my students and I can use this data and do whatever analysis we want to do.

Jonathan 21:31
So, talk specifically about what you're researching and what your research interests are.

Prakash 21:38
So, I mean, hydro climatologist, I'm interested in how these climate election could then condition patterns that we've talked about, how they affect water availability in the state and by extension, you know, how they affect hydrological extremes. And here we are talking about floods and droughts and then also how they affect crop yield. This is particularly important because we are an ag state. I'm also involved in a very important state initiative, which is developing our state water plan. So, we we're collecting data. We are making forecast on what the water demand is going to be in the next 50 years, and that can help us,

know, prepare, know where the growth is going to be, what kind of industry, you know, in shifts and conservation. So, putting all this information together helps us be better prepared when it comes to managing our water resources here in the state, and especially since we share, you know, river basins across states with Georgia and North Carolina. So, it's really important to have a good grip on what is happening, what is going to happen so that we can plan accordingly.

Jonathan 22:46
A lot of people don't realize that states have water use plans, have long term water use plans, like you said, they have to predict for industry and for population shifts and whatnot. So how do you do this? What is what kind of tech technology and data do you use?

Prakash 23:04
So, a lot of it is basically we use it we use a lot of data that comes from various agencies. In some ways, we are data scientists. We collect data. Sometimes we go in the field and set up instruments to collect data. But a lot of my work basically is based on historical data, data collected over the last 5060, 70 years or more. We get the data from various sources NASA, USGS, NOA, these are the main agencies in the United States that collect, curate this data and make it available to researchers and the public in general. Anybody can go in in these data are made freely available. So, we get this data, and we analyze them. We look for patterns, trends, shifts, and that helps us understand what is going on. We also use hydrological models, hydro meteorological models. We use we use some that are already that have already been built and we couple these models with economic models and so on. So, there's lots of interesting things that we can do when we have the models, when we have the data

Jonathan 24:13
artificial intelligence. Everyone's talking about it. You mentioned machine learning. Talk a little bit about artificial intelligence. Is it being used and what do you think it will do to help this process in the future?

Prakash 24:28
Yeah, it's definitely, definitely being used, especially with all the data that we've collected that we've collected and are collecting on it on a daily basis. So, there's so much data that it's impossible for a human to sit in front of the computer and try to churn this and try to extract meaningful information. And this is where tools like machine learning comes into play. They help us really analyze this data and they are being used by the various weather agencies. They are still at kind of in some ways experimental phase. There is a lot of interesting papers coming out on how they these new tools with and now with more sophisticated and more powerful computers putting this together, how they are helping us see, you know, in, you know, things that we haven't seen before or make

makes some of the things that were difficult or time consuming or computer intensive. Th making these easier for us. So, there's a there's a tremendous room for before for growth here. There's a lot there's a lot to benefit from this from this revolution.

Jonathan 25:42
Prakash this has been great. You know, they're predicting a pretty active hurricane season. I think it's important for people to understand and the factors that go in to creating a hurricane. And I appreciate you coming on early and explaining that to us.

Prakash 25:58
Well, thank you very much. Thank you, Jonathan. This gave me an opportunity to really share my interest in and my work with the public. I hope it's going to be helpful.