Bruce Riordan (00:03):

Well, good morning to you all. We're here with the BCCN podcast. I'm Bruce Riordan, the director of the BCCN, and our special guest today is Daniel Swain, climate and extreme weather expert. He's with UCA&R and also WeatherWest. Welcome, Daniel.

Daniel Swain (00:24):

Thanks for having me back.

Bruce Riordan (00:25):

Well, we always enjoy talking with you because you can tell us all the facts and figures of what's going on. So let's start with the summer and then we'll talk about El Nino and looking forward. Talk about the record setting summer in Europe and elsewhere and California as well.

Daniel Swain (00:47):

Yeah, this summer 2026 has been a remarkable one in ways that has managed to be different from the ways in which recent summers have been otherwise remarkable in other places in the sense that California on the one hand has not had a record warm summer, unlike many recent summers where we have successively broken records year on year in some cases. This was not one of those years. It was still, I know we're saying this from the back half of August, so we're mostly through the official summer months. It was still warmer than average across the vast majority of the state, certainly the inland areas, and also the coastal areas in Southern California because that ocean has been really warming up this summer, a very humid summer in Southern California for anybody who's listening from LA or San Diego, uncomfortably so even, but not a record warm summer.

(01:41):

It would've been among the warmest on record had we not experienced the last 15 years of accelerated warming locally. But in that context, this was not a superlative summer in California, but that cannot be said for other parts of the Northern Hemisphere. In particular, parts of the Central and Eastern US have had a summer that is near or above all recorded summers in terms of the average temperature. So there've been some searing heat waves, but maybe even more notably, just unrelenting overnight warmth. It just isn't cooling off in the Central and Eastern US this summer. And then Western Europe is a whole nother story entirely. I mean, we just had a terrible summer in Western and Central Europe where we're particularly sort of centered in France and the UK and radiating out from there, an astonishingly hot summer, just a bewilderingly extreme summer. And that is even in comparison to recent summers that have themselves been record-breaking.

(02:44):

This is a part of the world where we've seen record-breaking heat upon record breaking heat upon record breaking heat. And then we went on to break those records by wide margins in a way that is pretty shocking. There was also a very low rainfall summer in a lot of Europe. And so the net effect of this, of course, has been unprecedented wildfires in different parts of Europe, including in places that really have very little experience with significant wildfires. The United Kingdom sent out an automatic emergency alert last week via cell phone to everybody in the country due to the extreme wildfire threat. And there were dozens of structures burned in wildfires that day all around the country. The Scottish Highlands are on fire. The marshlands in Germany have large fires. And in Western France, earlier this summer, we had a forest fire in the Pine Forest West of Bordeaux that essentially forced the largest peacetime evacuation ever in Europe and destroyed hundreds of structures.

(03:47):

I mean, these are not things you normally expect to hear from these regions. And the reason they're happening is not a coincidence that they're happening in the hottest summer on record and the driest summer on record in many of these places at the same time. I mean, there is a direct link there. There's obviously other reasons why we're seeing increasing losses and consequences from these fires that relates to the broader landscape and people living within it. But why now? Well, the answer really is that the summer has just been astonishing. And I think one statistic that really sums it all up is that even before the most recent record-breaking heat wave last week, and this one was even more extreme than some of the ones earlier in the summer in some places, Bordeaux, France had already experienced more days over 104 degrees Fahrenheit this summer than its entire recorded history going back 150 years.

(04:41):

So the numbers really are almost hard to believe.

Bruce Riordan (04:46):

What about wildfires in Canada and effect on the Northeast here and the Midwest in our country?

Daniel Swain (04:59):

Yes. Canada has had a severe fire season, notably not only in the part of the country that has seen a clear sustained trend toward larger, more severe fires. That would be sort of the Western part of the country. So interior British Columbia and Alberta. But this summer, yes, those places as well, but also more Eastern provinces, Ontario and Quebec had quite severe wildfires earlier in the summer. Some of these even crossed the international border into Minnesota. But the main effect of these fires, these weren't hugely structure destructive fires because they did burn in some structures, but they're burning mainly in pretty remote areas. There's some small communities that they affected, but the big effect was the enormous volume of smoke, particulate matter, that entered the atmosphere and then caused terrible air pollution in the Central and Eastern US. Places that have not as much recent experience with it, Chicago, New York, Washington, DC.

(05:58):

There have been a few recent summers where New York and DC have had some significant smoke from Canadian wildfires, but this summer was in some ways even more widespread and prolonged than that. And now more recently, we've got some really bad fires in Southern British Columbia that have been very destructive, that have destroyed probably hundreds of structures. There's mass evacuations even now in the Okanagan Valley. So Canada has had another severe fire season. And as recently as 10 or 15 years ago, it was a little bit harder to say that Canada clearly had an escalation in wildfire activity and warming climate, but that's no longer ambiguous. Now it's very clear that Canada does have a pretty big problem, particularly in the boreal forest region, which of course encompasses much of Canada, this dense, highly flammable forest, which it is this tree species that grow there are inherently flammable when it gets dry enough.

(06:54):

That's just sort of how they're biologically constructed. These black spruce trees, for example, when they burn, they burn at a high intensity and you get stand replacing fire as the norm. And so the difference historically would be you would get occasional patches of high intensity fires infrequently. And it would still be high intensity, but it would be infrequent and localized. And you get some places where it would smolder, wouldn't really burn the tree canopy. Some places where you get a crown fire and you get this heterogeneous landscape. And the problem now is we're getting every summer, huge

swaths of high intensity stand replacing fires. So all of that carbon, all of that organic matter essentially turning into smoke and blowing down wind into New York and Chicago. And now we're seeing these massive swaths of area burned in Canada pretty much every year. And it's becoming a really big problem in a country where there aren't as many people, of course, in Canada in general as the US, there are much less populated portions of Canada and you can't really fight boreal forest fires in any meaningful way.

(08:02):

You can maybe hopefully get people out of the way, maybe harden your structures so they're less likely to burn, but you can't really meaningfully extinguish that kind of high intensity, large scale remote area fire. It's something that if you're lucky, it'll go out when the snow arrives in the fall or winter. And increasingly even that hasn't been enough as we've seen these over wintering so-called zombie fires that smolder or burn underground and the root systems and repeat during the winter under the snow pack. And when that snow pack melts, these fires then just reemerge spontaneously in the spring and just keep going multiple years now.

Bruce Riordan (08:43):

Let's talk about two things that you mentioned there in the overview and say a little more about nighttime temperatures and the importance of that for health and all. And then secondly, talk a little more about the ocean temperatures, where we're seeing records. So first on nighttime temperature.

Daniel Swain (09:04):

Yes. Well, July 2026, so this past July was now officially, according to many records, the hottest single month ever recorded in the lower 48. So when the continental contiguous US states, I guess I should say the contiguous, but a lot of that anomalous warmth came from not so much. I mean, the daytime temperatures obviously were elevated as well. They were near record-breaking, but the really record-breaking heat actually came in most parts of the country at night, meaning we don't think as much sometimes about those overnight temperatures. You think about, oh, what is the daytime high temperature? Which as you'd expect, usually you reach it sometime in the afternoon when the sun has been out and the sun is strongest before sunset. And by that measure, this was I think probably the second hottest summer on record. But if you actually look at the temperature throughout the 24-hour clock, and in particular include those overnight minimum temperatures, we had an unbelievable volume of what are known as record warm minimum temperatures.

(10:06):

This is kind of a tortured turn of phrase, but it really just means the temperature at night doesn't drop below some level that is itself really warm. For example, there have been a couple of nights this summer where Phoenix, Arizona never dropped below 95 degrees Fahrenheit. So not a single hour, not even a single 10-minute period at any point during a 24-hour cycle when the temperature was less than 95 degrees. That's obviously an extreme example. Phoenix does often see overnight temperatures that are near 90s sometimes during heat waves in the summer. But we saw across a lot of the US many, many nights where temperatures didn't get below at any point, and sometimes for weeks at a time, 70s and 80s and getting close to 90 degrees. And that's in places where that's much less common or really unprecedented in the central US, the Southern US, the Northeastern US.

(10:59):

And it may not feel as dramatic as those 110, 115 degree extreme high temperature days in the afternoon, but it really is highly consequential for a number of reasons. One is human physiology. We

need that overnight temperature recovery for our human bodies to physically recover unless you have access to blasting air conditioning all night. And even if you do, it's both energy inefficient and expensive to keep it on all night. But if you want to stay cool, that's actually what you got to do on nights like this. But for those who don't have access, it means for days on end, you have no reprieve and your body just gets this cumulative heat stress that builds day on, day on, day. And again, even for those who do have access to cooling, maybe you have access, but it's beyond your budget to keep that air conditioner running all night.

(11:49):

So you still don't cool off as much as you would have to, or you don't have any at all, which is not uncommon in some parts of the country that this summer were really, really warm. So human physiology, this is a problem. It's also a problem for ecology because there's a lot of species, terrestrial plants and animals that also rely for various reasons on this overnight temperature recovery. And one dramatic effect is on wildfire because the warmer stays at night, the less humidity recovery. So usually as temperatures drop, humidity rises at night. That's just sort of the general cycle of things. And those temperatures don't drop and the humidity doesn't rise. You get wildfire activity that doesn't die down as much or at all at night. And this is something that's been documented scientifically. Now there's really good evidence this is occurring. It certainly matches anecdotes from wildland firefighters and fire chiefs that I've talked to where you're saying in the '80s and the '90s, you usually could approach a fire at night somewhat more safely because it just wouldn't be doing as dramatic of these kind of up slope, down slope runs.

(12:55):

And now you'll see fires that don't really change their behavior that much on many warm, dry nights that we're seeing more often. And so this ends up meaning that instead of a eight to 12 hour period of peak burning on a lot of these fires where you'd have advancement, significant fire behavior for eight to 12 hours a day, and then you'd have an eight to 12 hour quiet period where you could regroup, put people in safely, and also the fire just wouldn't be constantly advancing. It's essentially like saying we now have twice the amount of time. If a fire burns for 10 days, it used to burn for about half of the hours in those 10 days, and now it's burning twenty four seven a lot of the time. So it has huge consequences for wildfire. And we've seen that in Canada, we've seen that in Europe.

(13:42):

We've seen that in the interior Western US this summer. And even though California has had, I mean, knock on wood somewhere at least through late August, a relatively mild fire season, at least compared to recent years, that is not true of the rest of the interior Western US. Oregon has seen by far its most acres burned of any full fire season on record already as of August, and there's still a couple of months to go. Washington has had its most destructive fire season on record with well over a thousand structures burned. They've never seen anything like that before in Washington. Utah getting close to a record both for area burned and structures lost, and Colorado is in the top three for both as well. So California's relative gain in this case, it doesn't necessarily extend to the rest of the West this summer where again, we talk about is this coincidental or not?

(14:35):

I don't think it is because we saw a winter that was record warm in most of the places that are currently seeing extreme wildfire activity in the interior west and record low snow pack in a lot of those places as well. So not the only factor at play, but it's a big one.

Bruce Riordan (14:50):

What's the science behind why nighttime temperatures are going up faster than daytime in many places?That's

Daniel Swain (15:01):

A good question. And it's actually, you might think this would be something that had an obvious answer, but it actually looks like there's different factors at play in different regions. And it partly comes from the fact that you kind of have to have things line up just correctly for extreme daytime temperatures to continue rising at the same rate on average, just because there's a little bit of a ceiling on how hot that narrow layer of what's known as the boundary layer can become the lowest layer of the atmosphere where we live because it actually, as temperatures rise, that boundary layer gets thicker through increased turbulence, through increased thermal activity. So you see the birds, the birds of prey flying around, the paragliders are taking advantage of those aggressive thermals. That layer actually gets thicker the hotter it is. And so you're actually able to dissipate even if there's more energy overall over a thicker layer.

(15:56):

And so the temperature in it doesn't necessarily need to rise as fast if you're giving more air volume essentially for it to. But at night though, the boundary layer shrinks. We have a much thinner layer of the atmosphere in which a lot of that excess heat is accumulating. And so it's a little easier for those temperatures to warm at night. So that's part of it. The other thing is that there seems to be a difference in how clouds are changing on average between the daytime and the nighttime. And it turns out that essentially the net effect during night is that the cloud changes we're seeing on average are favoring greater trapping of thermal infrared radiation. And the changes we're seeing in clouds the daytime have the slightly lesser thermal sort of heat trapping effect on average, although this actually varies quite a bit from place to place.

(16:46):

So there's that. And there may even be something going on with water vapor itself because we know that in a warming climate, the total volume of water vapor on a mass basis, not necessarily relative humidity, that's a different story, but the density of actual water molecules in the air increases.

(17:09):

Total column water vapor as it's known. And that itself can change the radiative properties of the atmosphere in different ways during daytime and nighttime. Because of course in the daytime, we have two primary kinds of energy that are sort of bouncing around in the system. We have the incoming solar radiation, the actual, you don't look directly at the sun because the sun is directly impinging on the surface and there's energy in the shore of short wave radiation coming in directly. But there's also, there's infrared radiation that is radiating upward from the surface of the earth and still downward from the atmosphere itself twenty four seven. But the solar radiation is obviously only occurring during the daytime. So you actually have sort of both terrestrial and atmospheric infrared twenty four seven, but you have that solar incoming shortwave only in the daytime. And so that further complicates the picture.

(18:04):

So I know there's a lot of atmospheric science 101 in there, but the point is there's a few different things at play and actually I don't think it's fully understood in all cases exactly why that's the way it is. It certainly looks like that is the way that it is because that is what we are observing in a lot of places, but it's not always entirely clear that there's one clear reason why.

Bruce Riordan (18:26):

Okay. Well, before we go ahead or look ahead at El Nino that's building and this fall and into winter, talk about what's happening right now with ocean temperatures because we're seeing record temperatures. I saw something the other day that said that the Mediterranean Sea that day on average was actually hotter than the ocean temperature in the Gulf of Mexico on average that day. What's going on with the ocean here?

Daniel Swain (18:58):

Yeah. And although I can't directly verify that specific statistic, it might depend on the unit of measure. It was close enough that I don't think it's a ridiculous claim, which is extraordinary enough. We're talking about water temperatures around or above 90 degrees Fahrenheit. I mean, this is bathtub water we're talking about. And the Mediterranean Sea is not a tropical ocean. We do sometimes see oceans that warm literally in some parts of the tropics, not even in all parts of the tropics, depending on ocean currents. But the Mediterranean Sea is a mostly enclosed basin. So it does in fact act. The oceanographers will, I'm sure, quibble with the bathtub characterization, but it is more like a bathtub than the broader oceans in the sense that there's a relatively small outlet. The water doesn't have as many places to go. And you do have a lot, the sun is just sort of baking, putting all this excess energy directly into the ocean surface.

(19:56):

A summer like this one where the air temperatures are hotter than usual and there are fewer clouds than usual, there's just a relentless input of the solar energy directly into the surface ocean. And it's record-shatteringly warm. I mean, it is just an absurdly warm ocean. Although interestingly and alarmingly, it isn't just the Mediterranean. This actually extends all the way into the open Atlantic west of France and in the English channel between the UK and the European mainland. So this is a big deal. I mean, the water is bizarrely warm. We've heard all these increasingly ridiculous sci-fi headlines, like the France nuclear power plants crippled by jellyfish. I mean, the headline is just something that literally looks unreal. But the real story there is actually really genuinely remarkable, which is that all the inland nuclear power plants had to shut down because there's no more cooling water available because the rivers have literally run dry.

(20:57):

And then the coastal plants, which were built to hedge against this risk because at least the ocean's always there. Well, the combination of the ocean itself being so warm that water is not, the temperature gradient is no longer what it needs to be to effectively cool the reactors because the water is pretty warm to begin with. And for reasons that are still trying to be rapidly uncovered by marine biologists, there's an interesting NPR segment I heard yesterday. We're trying to figure out why these massive jellyfish swarms are occurring. And there's a hypothesis that it's probably related to the record-breaking warmth itself. So speak of unexpected cascading impacts in a warming world, massive jellyfish warms, nuclear reactors, unprecedented warmth. I mean, it just sounds kind of ridiculous. It sounds like an overwritten Hollywood film, and yet those are the headlines in Europe this summer.

Bruce Riordan (21:54):

We had breaks in the World Cup soccer football matches this summer for the first time. Actual breaks in the games for hydration as they were calling it because of high temperatures.

Daniel Swain (22:09):

Yes. And that's interesting, I think, in two ways. One is that, yes, it's partly a function of the fact that in the places most of these games were being played, it was highly anomalously warm and humid. That's part of it. And so that's increasingly a reality of outdoor sports, among other things, in a warming climate. But the other part I think that is maybe the silver lining is that we probably should have been having those hydration breaks in the past because there have been other very hot periods where people play outdoor sports and become very ill. So it is also maybe at least an acknowledgement that we do need to be taking the impacts of heat seriously for those working outdoors. And those are laborers. They're doing a different kind of labor than somebody on a construction crew or in a farm field, I suppose.

(22:57):

But it is still outdoor work that can become dangerous if you're exposed directly to the elements when it's that hot and humid.

Bruce Riordan (23:03):

Sure. We could do probably a whole hour on outdoor sports and climate change because it's happening and it's going to be a big deal when more people in the sports world understand this, which has been slow to happen, I think.

(23:20):

Okay, that's great on a quick overview of what we've been seeing this summer in many places, land and ocean. Now let's talk about El Nino and going forward. So first, can you start, I mean, we're going to get El Nino on top of all this warming from the hotter planet. Can you explain first for our audience briefly what El Nino is? And then let's talk about what we're seeing already and what it means.

Daniel Swain (23:52):

Yes, yes. And I'll also make a bit of a plug. We scrambled yesterday and into this morning at UCA&R and the California Institute for Water Resources to put out a one-page fact sheet given all the demand for this. So that is officially out. You can find it. It's all over social media. I think ANR is putting on a press release. So if you want to refer to something, that's a great thing to refer to. But yes, so El Nino is by definition the warm phase of a natural ocean climate cycle that occurs on a semi-recurring basis every two to seven years or so. Its counterpart being La Nina. The broader cycle is referred to as the El Nino Southern Oscillation or ENSO is the acronym. But really that is what El Nino is in a nutshell, is it a temporary anomalous warming of the Eastern Tropical Pacific Ocean?

(24:40):

It isn't something that happens in California per se. It's something that happens thousands of miles away between the Galapagos Islands and the Peruvian and Ecuadorian coasts. And yet it can and certain cases have a big impact on California. And this is one of those cases because we already have a strong El Nino occurring today as of this conversation in late August, verging on record-breaking already for August. Actually, by some measures it is already record-breaking based on the magnitude of the warmth in the Eastern Tropical Pacific Ocean. And actually we expect it to strengthen fairly dramatically from here. So from the cusp of record breaking to something well beyond that, where have we heard that before in terms of record-shattering events this year? There've been plenty of them and I think we're going to see a lot more of them with this likely record-breaking El Nino event.

(25:29):

So as of now, the single most likely outcome, and NOAA is now explicitly predicting that there's about a 70% chance of a record-breaking El Nino event this year, which is a pretty remarkable prediction because I don't think that's a prediction that's ever been made before with such high confidence at this long lead time. So okay, we got a strong El Nino. It's going to get stronger. We'll probably become record-breaking. What does that mean more broadly? Well, globally, it means that we're almost certain to have record-breaking global temperatures in late 2026 into 2027, which you might say, haven't we already been having record-breaking temperatures? And the answer is yes, and we're probably going to start breaking those records again by even greater margins. And if that sounds alarming, it should because I am personally and professionally alarmed by this, but it also means that it will temporarily, because of course the warming from El Nino is temporary, the warming from climate change is not, that's here to stay.

(26:24):

It will temporarily elevate these global temperatures accentuating the effects of global warming, accentuating the already substantial effects on the hydrologic cycle through increasing the risk of droughts and floods in different parts of the world. And that's kind of what El Nino does. It shifts storm tracks. Some places see greater risk of flooding, some places see a greater risk of drought. It isn't just uniformly wetter or dryer everywhere. It depends where you are. And where we are and where we're talking about is California. And so I think the big question is, will this matter for California? And I think here it's important to differentiate, as we do in the fact sheet, that El Nino or not is not really the question. If we were talking about a week to moderate event, we'd kind of be shrugging our shoulders and saying, yeah, maybe there's a little bit of a tilt in the odds, but it doesn't mean a lot in terms of what we can definitively say.

(27:16):

But we're not talking about a week to moderate event. We're talking about an event that at a minimum will be among the top three strongest we've ever seen and at a maximum will be by far the strongest we've ever seen. So superlatives are warranted. Some people call it the super El Nino, which is really just a colloquial term for very strong El Nino, stronger than strong. So you can kind of think of them as interchangeable. There's nothing special about a super El Nino other than that it is literally warmer than a strong El Nino event. In California, there's sort of three main things I'm really keeping an eye on, one of which has already begun, which is warmer nearshore ocean temperatures, especially in Central and Southern California, and then eventually Northern California too. We are now starting to see this, and the water in Southern California is now well above average.

(28:07):

In fact, it has been for much of the summer. It's been very muggy, humid in LA and San Diego, uncomfortably so, like Florida level humidity even, legitimately Florida level. And I think people are surprised by that maybe in Northern California because it hasn't reached Northern California yet. But in Southern California, this has been an exceptionally humid summer in some cases among the most humid summers on record because of this very warm nearshore ocean. So we're going to see more of that into the fall. Any late summer, early fall heat waves in California will probably be more humid than usual along the coast, which could increase the human health impact, especially in Southern California. The next thing is that the sea level itself will be higher. So we're already running about six inches ahead of high tide predictions because of this surge of ocean water. And that's probably going to rise further, another six plus inches by winter.

(28:56):

So about a foot of medium term sustained through the winter sea level elevation. So that's already significant onto itself. But then when you add it to about eight to 12 inches of sea level rise, so as much as a foot of sea level rise already, now we're talking about two feet above historical baselines. And then as some oceanographers at scripts have pointed out, unfortunately, and this is purely a matter of random chance, but this year, the 20-year tidal cycle, the astronomical cycle dictated by the orbit of the sun on the moon, which has nothing to do with El Nino or global warming, but still matters, will reach its apex in November and December. So the king tides this year will actually be among the highest we've ever seen. On top of the strongest El Nino event that we've probably ever seen, on top of sea level rise that have never been higher than it is today.

(29:47):

And then on top of that, we got potential for more direct path for storms to actually take aim at the Central and South Coast this winter, which means that the likelihood of at least a A couple of storms this winter that bring a foot or two of storm surge into the San Francisco Bay or into the coastal regions is higher than usual. So you stack these all up. And if we get, well, we know we're going to get significant king tides. So those are likely going to, you can put it in your calendar right now. King tides this year are likely going to cause major disruptions throughout the Bay Area, for example, because there's going to be a lot of coastal highways, a lot of coastal neighborhoods that are significantly flooded, perhaps more significantly than we've ever seen. I mean, this is likely to be comparable to 82, 83, 97, 98, but maybe plus an additional margin beyond that.

(30:38):

And that's actually pretty concerning. If we get really unlucky and we get a significant storm event during either of the two peak tide episodes in November, December, which again, this is the time of year when we would get big winter storms if we're going to get them, that could be a really major coastal flood event. So that's more conditional. I'm kind of keeping my fingers crossed. They don't perfectly overlap. They might not, and we might escape the worst of it. But coastal flooding is almost guaranteed to be a big problem because that's not dependent on rainfall or storms. I mean, we know what the tides are going to do. We know what El Nino does with coastal ocean levels. That is almost guaranteed to happen. And then there's the last piece, which is the one that actually everyone talks about the most, even though it's slightly less certain, although the level of confidence has risen quite a bit.

(31:26):

The odds of a wet winter are now high in California. I'd say the single most likely outcome for all of the California coast is a wetter than average winter. And there are considerably greater than usual odds of a very wet winter, especially along the central coast and in Southern California. And for these purposes, the central coast does include up to and through the San Francisco Bay Area. So we're talking about if we kind of cut California into thirds, the Southern two thirds of them have a very high likelihood now of a wet winter and a considerably elevated likelihood of a winter that could be wet enough to produce problems on the flood side of things. And that's maybe the least confident statement that we can make, which is El Nino still doesn't guarantee anything. Even a very strong one, even the strongest one on record doesn't guarantee anything, but it does strongly shift the odds in the direction of a wetter than average winter.

(32:20):

And therefore it also increases the risk of individual heavy precipitation events that could lead to flooding. And also in general, the flood risk is higher in a winter where you have higher than usual precipitation at background. Even if the individual storms themselves are not particularly remarkable

relative to a typical winter, just because everything is saturated. All else equal, if you've already had a lot of rain and the rivers are running relatively high and the soils are relatively saturated, it doesn't take as big of a storm to produce significant flooding just because of that anti-seed and saturation. So that's the kind of concern that we have later this winter. So the sea level issues will probably pop up sooner. That could be an October, November problem into December. The rain is more likely to be an issue later from December really through March. So don't be surprised that this fall is not wet.

(33:14):

I would not be at all surprised that this fall is somewhat unremarkable from a precipitation perspective. That doesn't shift our priors regarding what might happen beginning around December in terms of the potential for a very wet rainy season, which it does shift the risk of drought down. So that's the good thing, but it probably also shifts the risk profile more toward flooding than drought. And so that's sort of the shift in the tilt and the distribution this year.

Bruce Riordan (33:45):

Let me try one more add-on question here, Daniel, just for a couple of things at the end. I was told years ago when we were working on sea level rise here, and this came from USGS scientists who were really good, that they had been asked to model a major tropical storm or even hurricane hitting Southern California because sea level rise, but also because of the great increase in ocean temperatures, warmer waters off the coast of Mexico and then Southern California. Is that something that with these big storms or bigger storms this winter, maybe we could see something like that, a tropical storm hitting Southern California?

Daniel Swain (34:37):

Well, it's an interesting question. And they're actually, I think possibly for the first time, there was actually just a peer-reviewed paper published on this this summer. My former advisor at Stanford, Noah Diffenbaugh is a co-author on it actually. It focuses mainly on the precipitation hazard that would come from that, because actually that is likely the biggest risk of a tropical system coming close to California is the likelihood of flash flooding because it could produce very heavy rainfall on the mountains. In a way it's a bit different than we get for winter storms. But the broader question stands, what does it take to get a tropical storm or even a hurricane potentially into Southern California? There are a couple of instances of this happening. There's the, I think it's the 1939 Long Beach tropical storm where this actually happened. And there was probably in 1858 a hurricane that came very close to making landfall in San Diego.

(35:33):

So it's at the edge of what's physically possible in the current climate. One of the barriers is that the oceans are just too darn cold. So even those ones that have made it didn't make it because the ocean was ridiculously warmer than usual. They made it because they made a beeline for the coast. They didn't have time to fully fall apart before hitting. As the oceans warm, it's going to be easier for those systems to not fully fall apart. They're still going to be rare. We're still not going to see tropical storms or hurricanes with any regularity, but the odds of an errant one not entirely falling apart before making it here probably are already higher than they used to be and will further rise. And notably, the odds are always going to be higher during a strong El Nino event in any particular climate, Epoch, because usually there's several degrees of additional temporary warming as there is this year.

(36:23):

The ocean temperatures off the Scripps here in Southern California are close to 80 degrees Fahrenheit right now. They're very warm, still not enough to sustain a hurricane intensification, but it is enough to maybe attenuate the weakening of an existing hurricane that makes a northward trek. So that wouldn't be something that happens in winter, by the way, because the ocean temperatures, just the background state is cooler. It would be something that would happen, well, from probably sometime between August and October would be the peak season where the oceans are warmest and when the atmospheric wind steering patterns are at least occasionally amenable to this happening. So the odds in general are very low, but rising relative to their very even lower historical baseline. I think the main risk is probably from very heavy rainfall if something like that were to happen. But there are some other issues too.

(37:12):

And I think this year, and in general, the risk of storm surge from winter storms is actually higher because, well, we have a lot more winter storms in California than we do summer storms. And I think the alignment with the king tides just astronomically is often such that the highest natural astronomical tide cycles often are more likely to overlap with a winter storm than a tropical system. And just one more meteorology 101 lesson, the main difference between a tropical system and a winter storm is that those tropical systems inherently draw their energy, their strength from the latent energy stored in very warm tropical or subtropical oceans. Whereas winter storms don't care as much about the amount of ocean warmth. They often form over very cold oceans. Baring sea, for example. They derive their energy from thermal contrasts in the atmosphere. So places where there's a very steep temperature differential.

(38:14):

That gradient itself is what these cyclonic systems derive their energy from. So structurally they're quite different. In terms of impacts, you still get a lot of rain and a lot of wind out of them potentially, so they can both cause problems.

Bruce Riordan (38:27):

Well, thanks very much for taking the time with us. We know that you are overwhelmed these days with the requests for your expertise, but thanks for talking to us here at Berkeley today. We've been talking with Daniel Swain, climate and extreme weather expert at UCA&R and WeatherWest. You can follow Daniel on the web at WeatherWest. And one more time, give a plug for the El Mino fact sheet. Daniel?

Daniel Swain (39:01):

Yes. Yes, that's right. Thanks for the reminder. Yeah, that came out fresh off the presses this morning, August 20th, and you can find it. I've shared it all across social media, A&R sharing it on their website through press releases. If you can't find it for some reason, feel free to just shoot me an email directly and I'll pass it along.

Bruce Riordan (39:19):

Great. Thanks for giving us all the info and background. We'll be back in touch as this summer concludes over the next month or two and as El Nino builds.

Daniel Swain (39:31):

Yes, indeed.

Bruce Riordan (39:32):
Well, thanks, Daniel, and be well.

Daniel Swain (39:35):
Thanks again, and likewise.