CLIMAS: Climate Assessment for the Southwest - October 2014 Southwest Climate Podcast
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CLIMAS Climate Assessment for the Southwest

Nov 2014 SW Climate Podcast:
A Warm End to autumn and Waiting for ENSO

In the November Southwest Climate Podcast, Ben McMahan and Mike Crimmins discuss the warm autumn weather in the southwest, the transition to winter weather patterns, the ongoing uncertainty of El Niño forecasts, a recap of El Niño conditions and definitions, and the possibility of interaction between El Niño conditions and weather patterns in the southwest looking forward.

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This transcript is our best attempt to capture spoken conversation in a written format – if you have questions, would like further clarification on a point discussed in the podcast, or would like more information, please contact Ben McMahan (bmcmahan@email.arizona.edu).

Ben: Welcome to the November Southwest Climate Podcast, my name is Ben McMahan. I am with CLIMAS as well. I am usually the one sitting behind the laptop and trying not to laugh, but today I get to actually contribute. That is because Zack is hard at work; I think he has a giant conference out of country. Zack will be joining us again, so don't worry faithful listeners.

Ben: So Mike, lets talk a little bit about the last month or so of weather since we last spoke. It seemed like after Simon, once the sort of tropical storm and monsoon system faded, we actually had quite a bit of above average temperature for most of October and into November.

Mike: We did, yeah. The temperatures were pretty impressive, running right up until about a week ago when winter kind of showed up in one day. I have been thinking about this and I have actually been trying to pull some real data together to put this is in some more climate context. But my experience with October living here in Arizona for the last decade now has been, when the monsoon is over, the monsoon is over. It is done, it dries out, the humidity crashed and you already start to get your cracked knuckles and those sort of things. We are loosing sun angle in October too because we are in fall at that point. So typically what happens in October is that every day gets a little bit cooler and then a little bit cooler. But what you really notice is the nights cool off really quickly. We just didn't have that this year. The minimum temperatures running right up to the middle of November have been way way way above average. That is what is standing out to me.

Ben: I think even that Zack mentioned that he felt that it was a cold front was coming through and on one of our conference calls; it was actually just a sharp change. It is not much colder than normal but because it was so warm for a while it feels that much colder.

Mike: If you look back at the last couple Octobers, it is not uncommon for us to hit low 50's or 40's even in October. It is cool; those would be below average, minimum temperatures. So we are already getting conditioned for winter in October. We get those swings and it will get back up to 90 but then it is really dry so you are getting these deep cool downs at night, we didn't have that this year. So it was striking to all of a sudden, what you would get a couple of tastes of in October, we were getting all at once at the end of November.

Ben: I think first widespread freeze warnings, were in the past week or so, is that correct?

Mike: Yeah in the far southeast Arizona, there were a couple of events earlier in November, but the ones that were actually reaching into the low deserts were very recent. And it was because the dew points were literally hanging out. The monsoon dew points, 50, 60, 70...we have 50 degree sort of lingering all the way through October and then lingering into November a little bit. We have 40 degree dew points extensively through November, and then the dew points crashed to about 0. So that is a big shift. That is from a tropical-ish air mass to the desert air mass we would usually get more of a taste of in October.

Ben: So where we are at now is more of what we would expect this time of year; it was just the speed of the transition.

Mike: It was pretty abrupt. It was like falling off a cliff, falling off dew point cliff. And if you look at the data, it really was falling off a dew point cliff, with especially the last cold front that moved through in the last week or so.

Ben: That speaks to the precipitation for the last month or so as well. I think post Simon and you mentioned the low-pressure system, but we really haven't seen anything since.

Mike: No and it is kind of weird. With Simon we have a little closed low that wanders right over Arizona in the middle of October. Some scattered thunderstorms with that event, kind of a strange event, nothing really frontal or anything like that. And then that moves away and we are kind of parked underneath this ridge of high pressure and it is high dew points underneath a ridge of high pressure. So what you end up getting is warm temperatures. You don't have that range between high and low, so we had warm nights, warm days and no rain. It was kind of a weird...it didn't feel like October or November. It was this weird middle ground; it is probably perfectly normal, but more rare.

Ben: We basically had no measurable precipitation during the last month or so. As a percent or normal it was really low, but when you have 0 compared to 1 or 2 inches, it is not much.

Mike: Yeah, it is a transition month. October is a mess if you look at the records with tropical storms like Simon. Tons of 0's for normal days and then early winter storms, so we had a little potpourri of some tropical storms, and then...it was a closed low so it wasn't a cold front by any means, so yeah that was weird. And then parked underneath a ridge, and it wasn't until 2 events in November, where they were honest to goodness cold fronts ushering in cool, dry air behind them, transitioning into more of a winter pattern.

Ben: Now that large cold front that you mentioned, was that the large one that pushed across the Midwest that seemed to affect quite a bit of the country?

Mike: No it was different. We had our own move across the Southwest here in the last week or so. And you get this pattern, where if it is cold in the East, it is usually warm in the West. Just because of the buckle in the jet stream and so when they had that really strong cool down, we were under the warm side of the jet stream when that was going on. If you watch the progression of the cold air, it was pouring straight out of the Arctic, straight down the Great Plains, made it into Texas and it made it up to the front range of the Rockies, Colorado and New Mexico and it was shallow and cold enough that we didn't get much of a back door cold front. Which sometimes will happen, the will rotate under the ridge and we will get a cool down or some strong east winds. We had a little bit of that but nothing major.

Ben: So that explains my relatives in the Midwest sending me very jealous emails and texts about living through this polar vortex as they were calling it, which I know its not actually

Mike: It was certainly of arctic origin and it was unusual in the sense that it was very early. There were some records all the way from Wyoming all the way to the upper Midwest that you ended up having some record low temperatures for November.

Ben: Well let's talk a little bit about moisture, specifically the tropic storm system because I think that might lead us into our El Nino discussion. This was actually a really active year for the Southwest. Conversely we had a quite year in the Atlantic hurricane season. But the 2014 Pacific hurricane season was the most active season on record since 1992. We had 20 named storms, we had 14 of those develop into hurricanes, 8 of those were categorized as major hurricanes, which is category 3 or larger, which actually broke a record that was held in the same year of 1992. So how much of that uptake in activity might be linked to El Nino patterns or sea surface temperatures or other conditions that are related to that? #00:07:32-4#

Mike: So there is a forecast made by Climate Prediction Center for Atlantic hurricane activity and the East Pacific hurricane activity. They knew going into the season that the Atlantic hurricane season would probably be below average and it absolutely was. The East Pacific would be above, so it was sort of a nailed forecast. What they were leaning on was the idea that El Nino was going to play some part of it. The interesting thing is that El Nino has been kind of there, but it has not been a definitive El Nino, it has been more of lurking in the background with some signals here and some signals there. But I do think that there was enough of the effect of some changes in the Pacific to probably relate to suppressing the Atlantic and enhancing the East Pacific. So what that ends up looking like is upper level wind patterns will sort of shift slightly and become more favorable or less favorable for hurricane activity. I think you certainly saw that, even if there wasn't coherent El Nino signals across the rest of the Pacific. I think even more importantly for the East Pacific. The fuel for tropical storms is sea surface temperature and we had that. It was warm; we had above average sea surface temperatures. Part of that was some slugs of warm water that had moved across the Pacific ocean from the West Pacific to the East Pacific, which are those Kelvin waves we talked about earlier. They will reflect and move up the coast both north and south. There was some of that going on but we also had a bunch of warm water across all of the pacific that had actually piled up over the last two years with our really strong ridge that had been along the North Pacific. So what had led to the very deep California drought right now, was a very stubborn jet stream pattern, a weak (?) low, which is usually a low pressure system that forms over the North Pacific during the winter. It has been kind of not really there. When you lose all of that you get a bunch of warm water that piles up in the East Pacific, from the North Pacific all the way down. That was really, after a couple of years started building up to this season. Sort of El Nino-ish, sea surface temperature patterns, circulation patterns, really setting the stage for a nice environment. Again that environment, warm sea surface temperatures but also no a lot of upper level wind sheer to tear these storms apart. So just a nice environment for tropical storms.

Ben: So listeners who may not be as familiar with hurricanes, if you are on the gulf coast you are probably would know that more...but in the Southwest it is not something we necessarily think about. It is those elevated sea surface temperatures actually amplify the effects of the hurricane or it can make them more intense.

Mike: Absolutely, again it is proportional to the energy that the storm is trying to use.

Ben: Fuel from the water and then the lack of that wind sheer that would pull them apart essentially.

Mike: Yeah because these storms form in an environment that is dynamically very weak. It doesn't have a big low-pressure system or a cold front or the stuff we are more use to in the high latitudes that really drive weather systems. It is basically a bunch of thunderstorms forming in the same spot and when they are big enough and they are firing off enough, they start to take on weak rotation because they are moving so much air from the lower part of the atmosphere up, the Coriolis force starts to come into play and they start to rotate. So if you have wind sheer, that is going to mess with the organization phase of these storms. You can

watch these storms flare up off the coast of Mexico and boy it didn't take long to go from disorganized storms to category 3, 4 and 5 storms within a couple of days.

Ben: So then we saw that pattern where early in the season they went further out to sea, later season we saw them kind of veer back in and that's where we saw about 3 or 4 relatively good size storms that came across the Southwest. That is the primary driver for a lot of that late season precipitation.

Mike: Yeah, some of them were sort of direct circulations making it inland and then that direct circulation brings both with it moisture and then the dynamics, which are important to sort of make it rain. That was Simon, Odile as well. But then we had plenty of indirects too. Norbert was not a direct hit. It was basically triggering a surge event. And then even, I think it was tropical storm Dolly sort of becoming an assist as well. So it was a really interesting summer, it had a little bit for everybody.

Ben: It really kept going, probably later than we sometimes expect with th tropical storm assist.

Mike: Oh yeah, when you get recurving storms they typically are much later in the season, so they just linger in October. We just haven't seen that in years. We haven't had quite the East Pacific set up that we did this year. Again, I think that is part of the lingering high dew points well into November, that whole area is sort of chugging along with moisture. If you look at Mexico, they have had exceptionally high dew points, even to this day. It is very tropical.

Ben: Lets zero back in on this El Nino discussion, because I think the conditions that helped drive the tropical storm season, now we are thinking more into the winter and how we are going to talk about El Nino...the possibility of an event and possibly even having already started. I think the Australians have already called it and said we are in an El Nino state. Now what that means...I don't know. I think I want to get a little bit of clarification because I feel like we have been in an El Nino state for 6 or 7 months. But they did officially upgrade it from a watch to an alert and put it around 70%. The IRI mid-month forecast came out and it was also (?) So ENSO already start...has El Nino already start? Are we just watching the conditions sort of catch up?

Mike: Yeah, this is the tricky thing about it. It is a little unsatisfying. You can't really declare and El Nino event, officially the way that the Climate Prediction Center does and IRI does until you are well into it. And with good reason. You don't want to sort of bob around with the sloshing water in the Pacific...

Ben: Otherwise you can say El Nino stopped and started.

Mike: Oh yeah, so I am looking at a trace, if you look at this box in the middle of the Central Eastern Pacific, right along the equator and you basically take the average temperature anomaly or the difference from average, so if it is half a degree, one degree warmer than it normally is for that period of time, then that it is going to give you an indication that you are warmer than average and that would be sign of El Nino conditions. You can measure this on a daily basis. There are weather systems going by and the wind is shifting directions, it is mixing out cool water from the top, mixing it down, so that temperature bobs around quite a bit. It is technically this 3-month window moving forward and it has got to be above a half a degree to call it. It smoothed out the weather noise, which is there. I am looking at a trace of it, 3.4. We call this El Nino index is 3.4, which is where the location of this box is in the Pacific. It is bogged around all over the place for the last eight months, but the interesting thing is that it has been above the threshold of half a degree since the middle of October. It has been climbing pretty steadily. It hasn't been doing the sort of day-to-day weather variation now; it is on its march up. If you just look at the last 20 days, it has met the El Nino requirement. The trick is, can it do this and hang there above at least half a degree on average for the next couple of months to get us officially to the El Nino.

Ben: So we need three straight months of that threshold?

Mike: I believe it is and it is a moving window too so it sort of moving forward. And again, like you said smoothing it out.

Ben: So we might be feeling the conditions of El Nino, a few months before it is officially designated.

Mike: I think that it right. I think where the Australians are sort of saying you get this El Nino-ish state without it being officially an El Nino. So it is a bit retrospective to call it an event. Because you could have El Nino like conditions and El Nino like impacts, but they are so short that it technically doesn't go into the record books as an El Nino event. It can happen, we had very La Nina like conditions last year but it wasn't officially a La Nina event.

Ben: Is that relatively typical? We stay in a neutral phase and we veer into these extremes or...?

Mike: Usually it is a little more clear cut. I think this middle ground is certainly there and in the record, but it is super frustrating when we think of this from a forecasting standpoint. Because moving into distinct states is so much easier to figure out what is going to go on and what you should expect over the next couple of months. So this way of moving into an El Nino event gives most of us a bit of a pause, is this thing really going to hang around, are you going to step up here and do your thing or are you just going to tease us for the next six months?

Ben: Well I think you have said before, both in the podcast and also in print, that a relatively weak El Nino event doesn't give us a lot of certainty as to how much precipitation. So this sort of vacillating on the threshold, whether it becomes one or not, may not mean a whole lot for how we...we may not know what happens until we see it.

Mike: Yeah, it is not forecasting at that point. It is sort of waiting and seeing, which sort of nukes the whole idea of trying to make a forecast. And unfortunately we are in that spot. There has been a lot of hedging for, okay it will show up and we will call it an El Nino winter. But I am still not sure, which is a little frustrating and I think just to build on your point...we call a weak event, which is at least above half a degree but less than one. It doesn't sound like much but it is enough for the atmosphere to really do different things depending on that change of temperature in that part of the Pacific Ocean.

Ben: And that is all one degree Celsius right? #00:18:07-7#

Mike: Yep, so when you get these weak events, it is almost an even split between below average, average and above average winters. It is like this mix bag of El Niños that are not clearly decisive what they bring. We are leaning on a wet forecast because there is this hope and prayer that this thing will give us a little more. It still is in there, it could really get organized and even push a little bit above. It is at 1 degree right now, which is technically; we are in the moderate El Nino. The models are just not convinced that it is going to stay at 1 degree for a long period of time. And if that is the case then, we can be sort of in this middle ground.

Ben: And that sustaining, what is that dependent on? I think you have talked before about atmospheric coupling and I think there seemed to be some hope that the resistance in the atmosphere had maybe been broken down a little bit? I don't know if that is the right metaphor.

Mike: No it is good, and the sustaining is that there is coupling. There is now a cluster of thunderstorms in the Central Pacific that is now sustaining the shift in the wind direction there and it is sustain that warm water in that spot. It becomes a feedback at that point. The warm water starting the storms and the storms are then driving the maintenance of that water temperature. That is where you start to see an enhancement of

the subtropical jet. All the things you want to see here to have the wet conditions. The ocean has been drifting in the direction of this pattern but the atmosphere...it is kind of yawning. It is kind of doing that again and part of it is very frustrating. Part of it is that there is very little temperature gradient across the Pacific Ocean. It is warm all the way from the East to the West and that is bad. You need to have this gradient in temperature. You need it to be cool in the West Pacific, warm in the East for the atmosphere to sort of reorganize around that. The Australians even said that in their ENSO wrap-up. They saw a little bit of cooling, they are anticipating more cooling but it is a lot of anticipating. We are sill not perfectly in gear.

Ben: So the general consensus seems to be that we are on our way into likely a weak to moderate event that will end sometime in the early spring of 2015.

Mike: Yeah, this thing could crash on itself in a month...technically again, it may not even register in the record books. It may be a neutral year, even though we have crossed the El Nino territory.

Ben: If it did that, 20 years from now they would never look back and say it was almost an El Nino?

Mike: No it would just be a non-year. I think the more important point is to look forward about the precip side of it. The dynamical models, even with this very unclear El Nino signal, have been very very consistent for eight months now. Not waffling at all on suggest above average precip for the Southwest through March and April. So there is something to that in the sense that they are not leaning on this being a perfect El Nino event, I don't know what they are keying in on at this point.

Ben: So maybe Mike, it would be good to revisit, we have talked about the ENSO signal and El Nino for 6,7,8,9 months now...maybe just take a quick revisit to what exactly El Nino is…

Mike: I think the first thing you have to do is visualize what is quote on quote normal. With maybe not intuitive thinking...okay so it is the tropics from the equator, it is getting a bunch of sun. So you would expect everything to be warm and all of that ocean water to be warm across all of the Pacific ocean because it is getting all of that direct sunlight. But what is actually normal is that we have got easterly winds that push across and go all the way around the world at the equator. But if you think about this big open expanse, the whole pacific basin, they are subjected to easterly winds all of the time. So what ends up happening is you get this flow of warm water, away from the South American coast, towards the West, so you get upwelling and you get cooler temperatures in the East Pacific and warmer temperatures in the far West Pacific. So that is what is actually normal. There is basically a magic number in the temperature of the ocean, that produces thunderstorms. So above 27.5 degrees Celsius, you get tropical thunderstorms and below that you don't. So you can envision if there is cool water in the East Pacific and warm water in the West Pacific, all of the storms are actually in the West Pacific, which is what you normally see. So that in its own right is interesting. All of that rising air has to go somewhere, so you get a circulation like we talk about the Hadley cell circulation. The rising air at the equator and it spreads out and sinks about 30 degrees north and south latitude. That sinking air is drying and that's where all the worlds' great deserts are, about the subtropical latitude. Well this circulation from east to west actually has its own circulation. So rising air in the West Pacific, sinking air in the East Pacific, it is called the Walker Circulation. So El Nino is when this sort of breaks down in one way. La Nina we won't even talk about today, I am just going to go right to El Nino. Again, think about this, what you would expect to see is warm water along the equator across the whole Pacific Basin, easterlies are pushing warm water to the west and cooler water is upwelling in the East Pacific. During an El Nino, again this is why the forecasting is so hard. The easterlies break down a little bit. We are not sure what causes that; it is a bit of a chicken and an egg problem here. So if the easterlies slow down at all, you don't have that upwelling and you start to have warm water in areas of the East and Central Pacific, which you don't normally have there. So if that water is now warmer than it usually is and it crosses this threshold of 27.5, 28 degrees, you start to have thunderstorms in areas you don't normally. That is the key. That is why we talk about this El Nino 3.4, this box in the middle of the Pacific Ocean. It is because we want

to know if it is going to get warm enough to make thunderstorms in that area, if it does...who cares? We care because if those thunderstorms shift around, the Walker Circulation changes and that has implications for the jet stream in both the northern and southern hemisphere. So in the wintertime, that movement of thunderstorm activity and the disruption of the Walker Circulation typically will enhance the subtropical jet. And the subtropical jet is a friend of the Southwest..well friend in these sense that you like rain. That is when you get into these El Nino situations, is that subtle shift in temperature and storm activity in the Middle Pacific could create a subtropical jet that could give us a whole new handful of storms that we don't normally see here in the Southwest. It wasn't a short explanation.

Ben: No, but I think it is good because we have been talking about it for so long that we get this idea that El Nino equally winter precipitation...but why? This explains why it isn't a consistent signal.

Mike: One of the interesting things too about these El Nino events is that, the jet stream typically splits. That happens in any given jet stream, this is the difference between how the Southwest and the Northwest sets up, is that the jet stream splits across the East Pacific and there is a big ridge of high pressure that basically takes the storm track north of the Pacific Northwest and we get our own Jetstream, call the subtropical jet, which will cut across Southern California, Arizona, New Mexico and Texas and Florida. The trick is it can set up just north of us, meaning here in Arizona or just south of us. So there is plenty and this is where get weak El Nino events. You can certainly see subtropical jet. But it is like plowing through Mexico, Southern Texas and Florida and we see nothing. We are caught in the middle between a storm track that is hung up over British Columbia and one that is south of us and we have seen plenty of those weak El Nino winters.

Ben: Given that it is still a relatively weak signal, looking for the next couple of months or so, what do you think is on the docket, whether it is El Nino related or not? Do you have any sense of forecasting or sort of the picture forward? I know the CPC has said mostly increase temperature and precipitation for all across the Southwest, any variation on that?

Mike: Yeah, it has been such an interesting weather watching of the last couple of weeks too. There was this expectation that we would move into El Nino-ish patterns. Where we would move into this subtropical storm track and for the Southwest we would start picking up some rainstorms and one of the more interesting things too is that the whole upper Midwest and the East were expected to be warmer than average for November because that is a very classic pattern in the El Nino pattern, the split in the jet and those kind of things. What ended up happening was...for some locations it is going to be the coldest and snowiest November on record and interesting enough, we have talked about this for the last six months, typhoons. Typhoons threw like big big wrenches in the atmosphere during the last couple of weeks. Super typhoon Nuri ended up getting...so they have recurving storms in the far West Pacific, they get sort of picked up and they move across the East, just like we have here in the East Pacific. They get picked up into the westerly flow. This storm recurved and goes to what we call extra tropical transition, so it changes into a typhoon into a normal low-pressure system. So the storm potentially set the lowest barometric pressure on record in the North Pacific. It was very very low, as low as super storm Sandy as it made landfall in the East Coast a couple of years ago. Very big and dangerous and deep storm and again, I can't wait to see the season of Deadliest Catch when they were out. But apparently some of the boats had sought harbor. So this storm, it is enormous. When you get storms like this, the jet stream across the entire planet has a ton of new energy to work out. So the jet stream gets huge waves in it and one of the waves was a very strong northward displacement of warm air across Western Canada. What goes up, goes down. So what goes north must come south. The cold air that was displaced was that basically, splitting off. So that displacement of cold air in the North had an equal displacement in the South and that cold air got displaced across the Eastern U.S. That is how you end up getting 10 feet of snow in Buffalo in several days out of season. Again, it is a typhoon. Which is a discreet, high impact weather event that is not forecasted beyond a couple of days. So there is nothing in the seasonal forecast...we had that typhoon effect all the way through typhoon season. It is

shutting down now because it is very very late in the season. You can't see that stuff coming. It has been really interesting in the climate community to have these discussions about, this throws climate forecasting into fits. Because the slowly evolving pattern, which is El Nino can be trumped by a single discreet event that can last for weeks. There is this other aspect to it too, which is really interesting, is that when you have these really dynamic disruptions to the jet stream, it can resonate all the way up in the stratosphere and then it can impact the formation of the polar vortex. It takes weeks if not months for the polar vortex to recover. You have this impact that could mess with the weather well into January now and no one is really sure how it will play out. At the same time, poor El Nino is trying to get some attention now and it may be completely trumped by this other higher latitude stuff.

Ben: So those extreme events obviously throw off the...well the forecasts and the outlooks that are made one, three, six months in advance are based on long term trends and expected patterns...

Mike: It is the slowly evolving part of the climate system. And the slowly evolving part is that these oceanic patterns...but these high impact weather events, we are learning, create real problems that resonate over weeks. All climate forecasting is really based on the slowly evolving part and this becomes a resonating thing. A little burst of energy ends up sort of resonating in the atmosphere by messing with patterns and having waves to try to move this energy around. It takes a long time and there are some things that we look to. We look towards the Northern hemisphere and the polar vortex to sort of behave in a certain way to have everything work out climatologically for the winter season. So when you get things like the polar vortex splitting in two because of something like this, it is hard for the models to even trace out what is going to happen going forward. And it could be one of these messes where you have an El Nino-ish signal...if you think about this for the East U.S., this is where the temperature pattern is a very clear warm signal for El Nino winters in the Midwest and the East. But this arctic oscillation can make it very cold. So you have now, two competing forecast signals and when you have competing signals you have no confidence. The models, when the have competing signals like this, they have a terrible time of resolving them and that is why you see these ensemble spaghetti plots going forward over the next 6 weeks. #00:33:27-6#

Ben: Like where you see extremes on either ends for what is predicted. #00:33:33-5#

Mike: So predictability has been very low, even the 7 to 10 day has not been very good. They are really struggling trying to resolve all of these things and so that then...can El Nino jive with this? Is it a completely separate variability and signal it is trying to work with? All this stuff is going to be related and it is pushing in the science community to sort of thing...like how do we get our heads around all of these moving things at the same time to improve the forecasting confidence.

Ben: If you extend the window looking backward....as I understand it, these extreme events can kind of drag the trend line in one direction or the other. As we move forward and have more data, does that data get blended in? How long does that impact of those extreme events affect the way we understand it?

Mike: It depends within transition seasons it is noisy already. So maybe the expectation is there. In the middle of summer, this is where if you look at the middle of summer, the impact of the typhoons on the jet stream pattern was really pronounced. We had some exceptionally cool weather across the Eastern U.S. that you can trace right back to the hurricanes. We are now in the winter so it is the same sort of jet stream response and pattern of cool east. But now it has arctic air to work with, where before it just had cool north polar air to work with, so now it is setting winter times records. To your point of the trends, it depends on how you calculate it and what data you are looking at and this is where we need to be a lot more sophisticated. If you look at the annual average temperature in a spot, you can see now with increasing variability if it is increasing and it seems to be. That path to that average to that average may have been convoluted. Where maybe in a year of low variability it was a very clear-cut answer of above or below. But maybe now, what if we get to a near average year temperature wise, but you set the record high and low for

the location in that year, that is different. We don't do a good job sometimes of thinking about the variability component and the average in the trend part.

Ben: That is intriguing, I imagine at the end of the season in the spring, when we look back at the winter...is the East going to say wow that was a crazy cold winter or that was a crazy cold November?

Mike: It will be interesting because of the Buffalo snowstorm. They got all of their annual total...again these are snowy places..a lot of snow, but they usually do it over a couple of months. Two and three foot events, but instead they get 100 inches in 5 days. They very reasonably, if the El Nino pattern takes over, could have a mild, not snowy winter and at the end could completely be on average.

Ben: And we saw something similar with Phoenix this summer. Almost all of their precip fell in one day.

Mike: That to me, the desert can do that. We are okay with that but when the East starts doing it, they pinging on our sort of desert climate variability a little bit. It has been fascinating. It will be interesting to see, if this ends up being a benign winter for the upper Midwest and the East, if everything settles down. The Pole is completely, the polar vortex is very unstable right now so it could actually recover and we go on and it is not an issue or it could split and this could be a big mess of higher latitude variability that could be competing with the El Nino part of this story. It is a super interesting unclear picture moving forward.

Ben: Fascinating from a climate perspective but very difficult from a forecast perspective.

Mike: Oh man, if you a forecaster, it is not a happy time. Not an easy task.