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## NOAA Webinar Series FAQ

### Talking Tornadoes with a Storm Researcher!

*This was such a fun experience! There were a ton of great questions and answers from everyone, so much so that we didn't get to them all! I wanted to take this opportunity to go back through the questions and answer them all (if I can!). – Sean*

#### **Q: Have you ever been close to a tornado?**

A: I've witnessed and been around a number of tornadoes over my career so far, and some of those I have been "close to" yes. That's a pretty random distance however, being 1 mile away from a 50 yard wide tornado is not the same as being that distance from a 2.6 mi wide tornado. However our science mission is not to be that close, so when I start to get close, I leave!

#### **Q: What state has had the most recorded tornadoes?**

A: This can vary by A LOT in a particular year, but if you look at data between 1991 and 2010, it looks like Texas had the highest average number of tornadoes per year (155). Texas is also a VERY large state so there's a lot more area for them to occur in. But every state has had a tornado! There's an article about this exact topic here:

<https://weather.com/safety/tornado/news/2020-03-26-average-number-of-tornadoes-by-state-each-year-united-states>

Aside from that average, 2004 had the most tornadoes in one year with 1,817! Tornadoes can happen anywhere and anytime the conditions are right. The conditions are more typically present in the central part of the United States, but have happened in California, Maine, Hawaii, or even Alaska.

#### **Q: Can tornadoes go on for days?**

A: There's no "maximum time" that a tornado can occur, at least not that we know of. If the conditions are still present for the formation and maintenance of the tornado, it can keep going. As of today, the longest lasting tornado (that we know of) was the infamous Tri-State tornado on March 18 1925, which travelled nearly 219 miles across Missouri, Illinois, and Indiana, and lasted roughly 3.5 hours!

#### **Q: What is the biggest tornado?**

A: The current largest tornado on record is the May 31, 2013 El Reno Tornado in El Reno, Oklahoma. It was an incredible 2.6 mi wide and had nearly 300 mph winds inside it as observed from a mobile radar vehicle. I witnessed this tornado and video of it was included in my talk!

#### **Q: Can tornadoes form on the ocean?**

A: Yes!, though it appears to be not as common. Additionally, when tornadoes form over large bodies of open water like an ocean, they are referred to as "water spouts." There are a lot less people out there to see them and almost nothing to hit! Over large bodies of water a tornado or waterspout can pick up water, and there have even been reports of fish being picked up!

#### **Q: What about dust devils?**

A: While dust devils and things like "land spouts" might look like tornadoes, they form differently. Land spouts, which can look a lot like large dust devils can happen even on days where there aren't clouds! The circulations that form them in a very basic way are similar to tornadoes, in that they require rotating air to form them. How this air acquires its rotation however is different for non-tornadic events.



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**Q: Why are tornadoes called that? Where did the word come from?**

A: The word “tornado” comes from the Spanish word “tornado” which means to have turned or be torn. I had to look that one up!

**Q: What is dewpoint?**

A: The dewpoint temperature is the temperature the air must be cooled to for the water vapor in the air to start condensing. If the air cools to this temperature and stays there, you can get fog!

**Q: How did you get your job?**

A: An interesting question! I started working with the NOAA National Severe Storms Laboratory when I was studying Meteorology while attending the University of Oklahoma. I found a passion with working on weather instrumentation and studying severe weather, so I started getting involved in the field projects that were happening at the time. Over time, I became more involved with the design and building of the equipment we use and it eventually turned into a full time position when I graduated college!

**Q: How precisely can we predict when tornadoes will strike?**

A: Unfortunately this is something we are still working on, but we've come a long way over the last 30-40 years! We know some of the general conditions that are supportive of tornadoes (which causes the NOAA Storm Prediction Center to issue a tornado watch), but we can't yet say which storm is going to produce a tornado and which one isn't. There are signs that a storm might be about to produce a tornado, and when we see those indicators the National Weather Service issues a tornado warning. Sometimes this happens far enough in advance that we can give some lead time before the tornado forms, but sometimes tornadoes can develop very quickly so it's best to always be prepared! And we don't know the exact path tornadoes will eventually take, which is why the warning box expands as it gets further away from the location of the tornado. This is similar to a hurricane forecast cone.

**Q: What should I do in a tornado warning?**

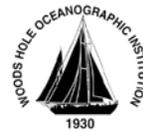
A: We get this question a lot actually. The best thing you can do in a tornado warning is have a plan and act on it! Have a bag ready with basic supplies like food, clothing, shoes, and a helmet among other things. If you are in a warning TAKE COVER! Don't wait until you see the tornado or try and figure out where it's going to go, take shelter until the warning has expired and the threat has passed. You'll find TONS of information at ready.gov, but the best thing you can do when sheltering in place is put as many walls between you and the outside as possible. If you have a storm shelter go there, but if not you can go to a bathroom or interior closet. If you have a basement even better as being underground can certainly help, but don't think you HAVE to be in order to survive. If you have a bathtub, get in it, the sturdy walls of the bathtub can help protect you. Take other steps to protect yourself from debris, like wearing a helmet or dragging a mattress over you. If you don't have anywhere in your house to shelter, you can identify a public shelter to go to, but go BEFORE the tornado forms. Don't wait until the last minute and try to rush there as you could be caught outside. And don't shelter in a mobile home, find a more well-built permanent structure to shelter in. If you are caught outside and don't have a shelter, find a low lying area like a ditch. The best thing you can do however is when storms start forming, find shelter! Most people who are impacted by tornadoes survive, as long as you prepare and plan ahead. This also means paying attention to the tornado warnings. There are multiple ways to get them, including cell phones, weather apps, tornado sirens, news broadcasts, and even alerts. Make sure you have multiple ways of getting warnings.

**Q: Can you explain the effect of climate change on tornadoes, is it making them bigger and more powerful?**

A: This is a fantastic question! The work that I do focuses on our shorter term weather, much shorter than the scale of climate change, so that is not something I can answer. There is a tremendous amount of work being done on climate change and people are looking at questions just like yours so check back and maybe we'll find the answer!



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**Q: How does terrain affect tornadoes?**

A: The influences of terrain are something we are still studying. Elevation changes like mountains or hills, changes in vegetation, or even differences in soil moisture could all have an effect. Mountains definitely have an effect on storm development and maintenance, so it's entirely possible it could have an effect on tornadoes as well. For example, air going up a sloping terrain could increase the rotation just like a storm's updraft. There are people currently looking at this exact thing!

**Q: What is the name of the vehicle that goes into tornadoes?**

A: We don't use any vehicles to drive into tornadoes directly as it's very dangerous! Our observations are focused on the outside of a tornado, trying to understand what's causing it to form. There are some people who have tornado intercept vehicles that do drive into them, but they are specially designed and armored vehicles and it is still incredibly dangerous. NEVER drive into or near a tornado!

**Q: Can tornadoes affect airplanes?**

A: During severe weather, airplanes are typically diverted around severe weather so they don't fly directly through it! There have been cases where ongoing tornadoes have been witnessed by planes however. If a plane were to fly in or near a tornado, it is likely the winds in the storm and near the tornado would cause significant problems for the aircraft.

**Q: Is it possible to have two tornadoes at the same time?**

A: Absolutely, though it is rare. There are cases, especially with large tornadoes, where smaller "satellite" tornadoes can form around the edge of the larger circulation. There are also cases where storms cycle, creating new areas of rotation that can spawn additional tornadoes even while the previous tornado is still going.

**Q: What's the deal with the tornado rating scale, are we the only ones that use it?**

A: The original tornado rating scale was called the Fujita Scale (F Scale), named after Dr. Tetsuya "Ted" Fujita who created the scale. The scale divides up the damage that is caused by tornadoes into six different categories. The minimum threshold needed for a tornado are winds of about 65 mph as this is where Dr. Fujita started to notice damage associated with the swirling winds of a tornado rather than normal thunderstorm winds. While there are certainly vortices that could have winds lower than this, they typically don't cause the level of damage tornadoes do and so aren't included. Today, we use the Enhanced Fujita Scale (EF Scale) as it includes updated damage indicators based on current housing structures to give more accurate damage ratings. The United States and Canada use this scale, though other countries have their own rating scales.

**Q: What causes tornadoes to form?**

A: This was what the webinar was all about! There are a lot of things we know about tornadoes, but there is still so much we don't. We are still actively researching exactly what causes tornadoes to form, but to a large degree it depends on balances between different air masses within a thunderstorm. As the boundaries between the air masses interact, it can cause rotation in the air feeding the storm. How this rotation leads to the formation of a tornado is something we are still looking at! We're also studying how they form, why they keep going, and why they ultimately dissipate.

**Q: Why are the conditions for tornadoes more favorable at a certain time of year/day?**

A: This is just typically when the conditions come together. Often severe weather needs instability in the atmosphere to occur, and this can require the surface to heat up. So in these cases the sun has to be out for a while before the conditions develop in just the right way. This isn't always the case, and there are plenty of times when tornadoes happen overnight or in conditions that aren't "typical," but looking over a long time period these conditions are most often met in the late afternoon and in the spring/summer months. It's also worth mentioning those times are a national average, which means specific locations might have their own peak at a different time.



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**Q: What is the best part of your job and why do you love it so much?**

A: Probably the toughest question! I absolutely love what I do. The research we work on is directly for the betterment of those around us. By understanding the weather and how it works, we can better warn and protect everyone in it and that's what drives me. I think what I love the most in this research is that there are no set paths. There's no answer yet to the questions we're asking, so it's exciting being able to figure out that path for the first time. Finding new ways to observe the world around us, creating new instruments, that's what I really enjoy about the work I do.

**Q: Are you a storm chaser?**

A: I am a severe storms researcher, which means when I go out seeking severe weather, including tornadoes, there is a specific science question I'm trying to answer. We collect data and take observations we hope will help answer those questions and lead to a better understanding of the world around us. But I do go out on my own, which I would consider "storm chasing." During those times I use my own vehicle, my own money, my own time, as a hobby. I've seen a number of tornadoes -- probably 50-60, the highest rated I've personally seen is an EF5 and I've seen tornadoes as small as 50 yards wide and a lot of different storms, which all have their own unique characteristics. I storm chase on my own because watching the atmosphere can be quite beautiful at times, but it's a constant learning tool as well. Watching how the different pieces of the atmosphere fit together and trying to better understand that is a process that never stops. I also do so because I have had a lot of education and training on how storms work. Otherwise it can be very easy to get into a bad situation. While it may be tempting, we don't recommend storm chasing on your own! It can be extremely dangerous.

**Q: Are you scared when you are there?**

A: I wouldn't say that I am scared of the weather, but I do have a healthy respect and appreciation for its power. The atmosphere around us can be beautiful and frighteningly powerful at the same time and I fully understand how quickly things can change. I've seen first hand the destruction tornadoes and severe weather in general can cause, and I think that's why it's important to remain calm and focused rather than scared.

**Q: What is the scariest tornado in your life?**

A: For me personally it was the El Reno, Oklahoma tornado on May 31, 2013. That tornado went on to become the largest tornado in recorded history as I watched it. Seeing something like that is a very powerful and sobering experience. While I had positioned myself to be safe and out of the path at a very reasonable distance, the tornado moved and evolved rapidly and it soon became apparent my location was not only no longer safe, but that I needed to react quickly to get to safety. By constantly planning ahead and being weather aware, I was able to adjust my location and get out of the way, however it was a very intense few minutes while doing so and watching the tornado coming at us. This was complicated by the fact there were so many other people on the roads that day, most of whom were just out there to watch the storm.

**Q: Where did you get that picture/video?**

A: All of the photos and videos I included in my talk were either ones I took, or some of my close friends took. If you're interested in using them, or getting a copy of this talk, it is available on YouTube or you can contact me directly.

**Q: Have you ever seen twin tornadoes?**

A: Yes! I've actually witnessed three tornadoes on the ground at the same time before. And while tornadoes don't have "aftershocks" like an earthquake, there can be multiple tornadoes from a single storm so always be prepared!

**Q: Can you see a tornado from space?**

A: I don't think so! Space is a long way away and tornadoes are pretty small compared to that distance, plus tornadoes usually happen underneath storm clouds, which would block the view. So while we can't study tornadoes '



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from space, we can study the larger storm that is producing it from space, which can help us understand why the tornado may be forming.

**Q: How many tornadoes are there each year or in just tornado alley?**

A: This can vary a lot from year to year. The average each year is roughly 1000 tornadoes, with most of those occurring in the Central Plains, called Tornado Alley.

**Q: You mentioned weather balloons, tell me more about those!**

A: These balloons are latex balloons, and are about four to five feet in diameter when we launch them. They carry a small package that measures pressure, temperature, and relative humidity, and can derive the wind speed and direction as it goes up through the atmosphere. The balloons go up until they expand so far the latex shreds, then the instrument falls back down to earth. There are videos of this on YouTube! They use a GPS to track their location so we know where the observations are, but we don't follow it all the way to the ground. If you find one you can send it back to the National Weather Service but some of them might land in the ocean and we never get them back.

**Q: Tell me more about tornadoes, it seems like there is so much to learn!**

A: There definitely is. Tornadoes can come in all shapes and sizes, occur at any time of day or year, happen all over the world, can change direction at a moment's notice, and we are still learning about what causes them. Tornadoes can look visually different too, with some appearing to not even fully connect to the ground or even be different colors if they pick up different soil types. We know a lot about them, and are getting an idea of how they form and why they differ. There are different "parts" to a tornado, but there are different aspects to it especially with how they form. Tornadoes can be very destructive, causing large amounts of damage and even entirely moving or destroying homes. Tornadoes can also occur over open fields and hit almost nothing (though crops can definitely be damaged). A lot of people want to compare hurricanes and tornadoes but they are very, very different. Hurricanes can have very high wind speeds but are also very large compared to a tornado. Each one of them has their own unique hazards and you should be prepared if you live in an area that experiences them.

**Q: That hail cage on top of the car looks crazy! How well does it work?**

A: The hail cage was designed to protect the front windshield and the occupants of the vehicle from large, damaging hail. The mesh has a one inch spacing, so anything larger than that gets caught and either shredded or deflected without impacting the window. While smaller stones can still make it through, these don't typically cause much in the way of damage. The hail cage has been tested with hail up to about 4.5 inches in diameter, though it could likely take larger. The largest recorded hailstone in the United States was in Vivian, South Dakota, in 2010 and was approximately eight inches wide. One might suggest using bulletproof glass. While that is a great idea, it is very expensive and can actually cause other problems like the window fogging up in certain conditions and not being able to get it to easily defog.

**Q: Can animals sense tornadoes?**

A: This is a great question! I am not sure of any official studies exploring whether animals can sense tornadoes or not, but I have personally seen cows react to a developing tornado that eventually moved through their field. The problem here is it's really hard to recreate the conditions, or ask them what they know!

**Q: Tornado research seems really dangerous, how do you guys stay safe?**

A: Trying to research tornadoes can be a dangerous job, which is why safety is our absolute top priority. We specifically design research topics so we can collect data safely, use specially instrumented and designed vehicles, have years of safety training and background knowledge of meteorology, and are constantly evaluating the current conditions to collect the data we need only when it is absolutely safe to do so. No data are worth risking our safety and there are plenty of times where we do not operate simply because it isn't safe.



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**Q: What time period were the graphs shown over?**

A: The statistics presented during the webinar span from 1954-2018.

**Q: What is CAPE?**

A: CAPE stands for Convective Available Potential Energy, and is a measure of how unstable the atmosphere is. It's based on the surface temperature and dewpoint, as well as how quickly the atmosphere cools off above the ground. Higher values of CAPE can mean faster vertical storm motions, but there's a lot that goes into it.

**Q: Do you also study lightning?**

A: Yes! I have done some lightning research over the years and the NOAA National Severe Storms Laboratory definitely does.

**Q: Do you name tornadoes?**

A: We do not name tornadoes.

**Q: Why were you taking video?**

A: Sometimes having a visual record of what happened can be really useful. There are studies that can be done by examining visual characteristics in the clouds and matching those to things like radar imagery. This is called photogrammetry.

**Q: Do tornadoes have calm centers like hurricanes?**

A: Not that we know of. There is nothing in the debris pattern or eyewitness accounts of those impacted by tornadoes to suggest it.

**Q: How do tornadoes in a bottle differ from actual tornadoes?**

A: When we create a tornado in a bottle we usually do it by mechanically spinning the water, typically moving the water container around in a circle. Since the water is contained, the water begins to spin and the rotation creates the funnel effect. Real tornadoes however acquire their rotation quite a bit differently.

**Q: How does what the tornado picks up affect the storm?**

A: This is a very interesting thought and something many people are working on today. Tornadoes can pick up and move all sorts of things, even water, and how those materials affect the winds inside a tornado are not yet understood.

**Q: Do you have a YouTube?**

A: I do, though I'm not super active on it. My YouTube channel is Mesonetman. I'm more active on Twitter (@mesonetman) and will be posting more to Instagram (Mesonetman).

**Q: Have tornadoes been seeded or have we tried stopping them?**

A: Cloud seeding has been tried for a number of years, but it is difficult to tell what effect if any it actually has. And over the years we've had suggestions of things like detonating bombs inside tornadoes to disrupt them. The truth is -- as crazy as it sounds -- this likely wouldn't do anything to disrupt the tornado or the storm and would potentially just make things much worse.

**Q: Can tornadoes join together?**

A: Tornadoes can't merge together to create bigger tornadoes (that we know of), though it could appear that way. Sometimes circulations can produce multiple tornadoes rotating around a single point as part of a larger spinning



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vortex. These smaller “sub-vortices” or smaller tornadoes can sometimes appear to rotate together as the larger circulation matures.

**Q: Why does hail fall before a tornado?**

A: This is a great observation, but it isn't always true. Oftentimes storms have to reach a certain strength before they are able to produce a tornado, and storms that strong can also produce hail. The tornado, and hail, typically fall in specific parts of the storm. Depending on how the storm is moving and where you are located, if you are in the path of the tornado it is possible you would experience the hail first, then the tornado. But this doesn't have to be true, and there have been plenty of cases where storms have produced tornadoes almost as fast as it takes to start raining!

**Q: Can you live if you are picked up by a tornado?**

A: The answer is yes, though the odds are not good. The strong winds and flying debris can make it very difficult to survive. There are cases however of people being moved by a tornado and surviving. We definitely recommend taking shelter so this doesn't happen.

**Q: Did you ever meet Tim Samaras?**

A: I did have the pleasure of meeting Tim once. He was an incredible researcher and a really great guy. His passion for his work and his dedication to bettering the lives of those around him was inspiring. It is tragic he lost his life pursuing that research, as it is tragic for anyone who has lost their lives pursuing severe weather.

**Q: How are you working from home?**

A: With everything going on in the world today, and following local, state, and federal guidelines, I have been working from home for several months! It has certainly been challenging, but it is giving me an opportunity to catch up on smaller side projects and paper writing, which is an important part of the research I do. After doing all of this work collecting and analyzing data, we have to communicate and share our results so others in the community can verify the results and the new knowledge can be shared. By doing that, we can advance our understanding of the world around us piece by piece. So paper writing is a very large part of any research.