Oral History Interview of
Joe Golden

Interviewed by: Andy Wilkinson
July 23, 2018
Boulder, Colorado

Part of the:
Wind Interviews

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Interviewer: Andy Wilkinson
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Interview Series Background:

In addition to interviews pertaining to the National Wind Institute, oral histories have been conducted with various individuals whose lives have been impacted by wind engineering in the Southwest. For example, interviewers have spoken with farmers and ranchers who witnessed the rise of wind turbines on their properties and adjacent lands, employees of electrical co-ops, and engineers who helped logistically create the large wind farms.

Transcript Overview:

This interview features Joe Golden as he discusses his interest and research in the field of meteorology. In this interview, Joe describes his work with waterspouts in the Florida Keys, and later his work on the tornado intercept project.

Length of Interview: 01:09:29

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Weather, Meteorology, Waterspouts, Tornadoes

Andy Wilkinson (AW):
Okay. Let me preface this by saying this is Andy Wilkinson with Joe Golden and we're in Boulder, Colorado, at his really nice home right on the edge of the country club. It's in the morning and I will say, for the record, a beautiful morning. After all the hot temperatures, we're going to have a nice day today.

Joe Golden (JG):
Yes, we are. We've broken—it's nothing for you flatlanders from Lubbock. The heat here is nothing compared to what you get. [Laughs]

AW:
No, but you know, I got to tell you, this whole summer, I've been spending time either in Colorado or in Santa Fe and every time, it's been almost as hot in both those places.

JG:
Santa Fe, too?

AW:
Yeah, as in Lubbock, and I feel really cheated.

JG:
You feel cheated? Boy, I could spend a whole summer in Santa Fe and that's like seventh heaven.

AW:
Well but I was cheated in the fact that I got up there and it was ninety-five and Lubbock was ninety-seven, you know? They've had a really hot summer.

JG:
Oh, okay. Now, do you want to talk about? Do you just want to talk—focus on waterspouts? Or do you also want to get into my work in tornadoes?

AW:
I want to get into everything Joe Golden and I want to start with some background on you and we don't—we probably won't finish an interview today.

JG:
Okay.

AW:
So it would be nice to kind of get started and then when I come back up, hopefully, to get material.

JG:
Okay. Well Kishor can tell you, from firsthand, that I sometimes can be longwinded.

AW:
Good. The worst—the absolute worst thing in an oral history interview is if I say, "Well what was that like?" And you nod your head. It doesn't do us any good.

JG:
Yeah. All right.

AW:
Well let's start off with a date of birth just so we know.

JG:
Oh, no.

AW:
Yeah, I'm sorry.

JG:
My granddaughter and my daughters view me as already older than dirt, but December 4, 1942.

AW:
That's not so old, I'll tell you. Where were you born?

JG:
Now, this is another thing Kishor may or may not remember, but my hometown has caused me to be the butt of many jokes from colleagues throughout my career because the first question they ask when they hear it, "How could any meteorologist come from such a place?" And so, my hometown is sixteen feet below sea level, fifteen miles from the Mexican border in extreme Southern California, and the average annual precipitation is three and a half inches in a year.

AW:
Yeah, so not too many storm clouds.

JG:
Right. And of course, some people, when they hear that, say, "Oh. You're from Death Valley." No, that's not fifteen miles from Mexico. And I'm from—the other thing is, is it's a very rich agricultural area. Grows many crops. It's El Centro, California. A hundred and twenty miles east of San Diego. Sixty miles west of Yuma, Arizona. Fifteen miles from Mexico.

AW:
So the agriculture there, is it canal water? Ground water?

JG:
Yeah. Oh, it's all irrigation. And in fact, one of the greatest engineering achievements in our country was the building of the all-American canal, which you could see from space. It comes off the lower Colorado River and it passes east—it passes westward just inside the U.S. border in extreme Southern California. So all of the farming is from—yeah, it's from Colorado River water and irrigation.

AW:
Yeah. Any ground water? Or is it?

JG:
No. No, I don't think so. They may—I mean—they may have some of these sprinklers now, but over the years, it's all been from irrigation. By the way, there are big battles now going on.

AW:
Oh, yeah. Well—

JG:
And we had a farm, which we sold. A family farm, which we sold about a dozen years ago because of these ongoing battles about water and farmers have either sold out or many of them are being paid to let their farms go foul, which is very sad.

AW:
Yeah, because of the water.

JG:
Because of the fights between San Francisco, Los Angeles, and Las Vegas over the rights for Colorado River water. Yeah.

AW:
Yeah, and right. We, you know, as you know, in Texas, the Rio Grande doesn't even hit the gulf

anymore. It's all gone. Did you grow up in El Centro?

JG:
Um-hm. Twenty-one years.

AW:
What—in that environment—what drove your interest in meteorology?

JG:
Well, my father was a professional engineer. Civil engineer and architect, but he really didn't talk about his work very much at home, but he was into scientific things and I think it was more my mother that got me interested in it. She used to let me run naked out in the front yard during a thunderstorm in the hopes that I would get wet, which rarely happened, by the way. Rarely happened. I mean, we used to talk about heat lightning and that fascinated me at an early age because the clog bases are always very high. About ten thousand feet. And I was just fascinated by thunder storms that we would get every summer. Only in the summer, generally. But you know, all of these high based storms and usually, very little rain. Just a lot of lightning and they seem to happen more often at night and still do. We now know that the moisture comes up from the Gulf of California. Yeah.

AW:
Yeah. We had heat lightning when I was growing up on the farm, too. We talked about that all the time.

JG:
So I—but I said I've been the joke of many—I've been the subject of many jokes about, you know, how anybody could interested in meteorology. But, and I actually—my first, and I'm jumping ahead a little bit. I got a partial scholarship to go to Berkeley straight out of high school. My initial major was in physics and math because I had no clue that meteorology was a career. Seriously. All I knew was—well there were a few of these guys on TV. Weathermen, you know. But I didn't think you could make a career out of that either. So I went to Berkeley. It was—for a kid from a small farming town, it was a bit overwhelming. I was majoring in physics and math. Barely getting by with B's and C's. I had professors in lecture halls that had five hundred students and the professors were Nobel laureates, like Glen Seaborg and another one wrote a famous book called, *Fail-Safe*. Eugene Burdick was one of my—

AW:
Yeah, really?

JG:
Yeah. And so I mean, I was barely keeping afloat. You know, getting B's and C's and so I began to wonder, "What am I going to do with this physics and math?" I didn't think I'd really want to teach and so then I happened to find out that the only meteorology at Berkeley was in a climate geography department, but then I found out by accident that UCLA had a full department of meteorology and a very good one. So after agonizing about it and I was in a local fraternity at Berkeley, so it was kind of tough to pull the chord there, but I transferred at the end of my sophomore year to UCLA and as they say, the rest is history. Then I had some really great professors there and met some friends and colleagues in classes there that are still friends and colleagues to this day. And in fact, my whole entry into the water spout arena was literally side-by-side with one of those UCLA chumps, who also went with me, by the way. We both immigrated at the end. When we got our bachelor's at UCLA, we both transferred to Florida State to go into graduate school. So the UCLA experience was a very good one and just prior to going into UCLA. [Phone Rings] I think it was—hold on. Let me answer that.

AW:
Sure.

JG:
Hello? Hello? Okay. We get a lot of robot calls. Go ahead. I'm sorry.

AW:
Oh, I understand. No, it's fine.

JG:
So anyway, I also got another really good working experience in the field as a student trainee in meteorology in the weather service. It was called the Weather Bureau then. And so in the summers of—I think it was '61 and '62. Two summers. I worked as a student trainee in meteorology at what was then called WBAS, Weather Bureau Airport Station San Diego, where my family used to go every summer anyway. And so I got a real heavy dose of the field there and it was all great. I mean, the meteorologist in charge was a very good mentor and his deputy was also a good mentor and so that experience really revved me up, you know? This might be—I might actually be able to make a career out of this. Maybe. Even though I'd gotten very discouraged at Berkeley. So I mean, those key early—those kinds of early career people were just absolutely critical and I've tried to—you know, I've tried to immolate what they did for me with other young people.

AW:
Are there—well I know they're all important, but what are some names of some of those that were particularly important to you?

JG:
Oh, that's easy. Andy Anderson was the MIC.

AW:
MIC, meaning?

JG:
Meteorologist In Charge of San Diego. I'm pretty sure that this is his name, Andy Anderson. Long since passed away. And his deputy was even more of a help. Curt, and I forget how you spell it, M-u-e-r-d-t-e-r. Muerdter. I think that's how you spell it.

AW:
M-u-r?

JG:
M-u-e-r-d-t-e-r. Don't hold me to that, but that was his deputy in charge at the San Diego Weather Bureau. And so—and there was another colleague with me, who I've kept friends with throughout the years. I haven't seen him much recently, but he's just across town here. His name is John Brown. He also worked there. He actually lived in San Diego.

AW:
Now, was he your colleague at UCLA?

JG:
Yes.

AW:
Yeah.

JG:
Yes, yes. He was also at UCLA. Yes. And so anyway, so he and I were both students there in the—I think it was '61, '62. It's so far back. But anyway, and so you know, we learned a lot of the basics, you know, of operational meteorology there. Like taking—you know, they taught us how to take a surface observation. They taught us. They showed us some of the measurement systems. They taught us how to take a pie ball, which is a pilot balloon observation, and so a lot of the basics and yeah. That was a very key—that was not only a very key experience, but you actually got paid a little bit. Yeah, I mean, it was—

AW:
Even better.

JG:
Yeah. I mean, it was just—what a program. I don't think they have that anymore, but they have something similar, I'm sure.

AW:
Was—San Diego—was that where you first got interested in waterspouts?

JG:
No. The key word throughout my whole career—the key word is 'serendipity.' All right? You're going to hear that again and again.

AW:
Good.

JG:
Serendipity. That's the whole thing right there. Very lucky. Being in the right place at the right time. Having people, a few people, that gave me a little push and yeah. The other thing you learn if you work for the government is that the Peter Principle is operative throughout your career. All right?

AW:
Yeah. I've worked for the government before.

JG:
Yeah. So there are people that rise above their level of incompetence. But fortunately, there are a few that you rub elbows with that are nurturing for others and good mentors and I'll give you specific names before we go. Before we finish. So I don't want to make the government sound worse than it really is, although the situation now is—it's absolutely horrendous, but anyway.

AW:
We are testing the boundaries.

JG:
Oh my god. Anyway, so yeah. That's—I think that's the best anybody could hope for, to be honest. And so anyway, so we'll jump ahead. So I finished UCLA. Graduated with a bachelor's.

AW:
What year did you graduate?

JG:
Sixty-four. Transferred to Florida State. I transferred there along with Bill Woodley, who was another close colleague that I stayed close with throughout the years. He and I both went to Florida State at the same time and for the same reason. We thought UCLA was too theoretical. Highfalutin, if you will. And—or was getting too theoretical and we were both interested in actual weather and especially, hurricanes. The tropics. I mean, hurricanes and tropical weather. Woodley actually got into weather modification and then I was going to study hurricanes and then I got sidetracked, as you'll see. The serendipity kicked in. So, but Woodley was very critical, a very close friend. Who was with me when the serendipity happened on the waterspouts. So we'll get to that.

AW:
Good.

JG:
Okay?

AW:
So he went into weather modification?

JG:
Yes.

AW:
Just a little short sidetrack note, but if you get back down to Lubbock again, I hope you do, we have a bit of a collection on what was called the Lamesa Rocket.

JG:
The what?

AW:
The Lamesa Rocket.

JG:
Rocket?

AW:
Yeah.

JG:
Never heard of it.

AW:
No? You probably wouldn't. It was a flim-flam [?] man who came to the little town of Lamesa forty miles out of Lubbock—

JG:
Oh, yeah.

AW:
With a rocket that was intended to make rain.

JG:
Oh, this is right out of the Bert Lancaster movie, "The Rainmaker." Oh, that. I love it.

AW:
Yes. There is—I've had one or two people say that they're convinced—

JG:
The original rocket man.

AW:
That this incident may have spurred that script and story. But we had one of my colleagues track down and finally found the rocket. It was never launched, you know? [JG laughs] After everybody put their money into it.

JG:
Well listen, we laugh, but I have to tell you that there is a real counterpart in real life that the Russians have used and the Germans have used for many, many years.

AW:
Really?

JG:
They have. The Russians had a very large program in hail suppression that used rockets.

AW:
Really?

JG:
They used rockets. Oh, yeah. And they claim with great success, by the way. It was very controversial, but anyway, so let's—all right.

AW:
Yeah. So back to Bill Woodley and—

JG:
Alright. So we transfer to Florida State. We both had the same major professor, who was Noel LaSeur.

AW:
LaSeur?

JG:
L-a. Capital L-a. Capital S-e-u-r. He passed away about fifteen years ago and he was a very big influence on both of our careers. So we both got our master's and PhD at Florida State and Bill got his faster than I did.

AW:
When did you finish up with your PhD?

JG:
All right. Master's in '67 and PhD in '73.

AW:
That sounds pretty fast to me.

JG:
Well, no. There were—anyway. And the title of my PhD dissertation was "The Life Cycle of Florida Key's Waterspouts as the Result of Five Interacting Scales of Motion." There's a mouthful for you.

AW:
That is.

JG:
All right. "The Life Cycle of Florida Key's Waterspouts as the Result of Five Interacting Scales of Motion." And the PhD dissertation was one of the longest ever successfully accepted by the faculty at Florida State. It was nearly five hundred pages.

AW:
Wow.

JG:
And I had to do a lot of cuts, by the way, because—

AW:
So you started out with more than five hundred pages?

JG:
Yeah, yeah. And I had to make a lot of cuts because my committee was getting a little bit—at first—but it was ironic because when I first got their approval to pursue waterspouts for a doctoral thesis, they said, "You're really going into something that's very risky. You may come up empty handed." And so—

AW:
And why was that?

JG:
Well nobody had ever—nobody.

AW:
Not enough?

JG:
No, there was so little. That's why I was drawn to it is that there was so little in the literature and the only significance—one of the—anyway, I'll show you a book before we leave that actually is—it just came out. It's a coffee table book, which I helped the authors kick start. I contributed to it and they did a great job. It's on European tornadoes and waterspouts. So the Europeans have a much longer history on waterspouts than we do, but you know.

AW:
I don't even think about a tornado as happening in Europe, though, you know?

JG:
Oh, yeah. Well they get a lot more than we used to think in Europe. Now, they're—and they're getting better organized, you know, for reporting them. So anyway, so went to Florida State and now, we're getting to the serendipity. The first serendipity. So I had some really good professors there. We were glad. I think Bill and I—Bill Woodley and I were both glad that we transferred there rather than staying at UCLA, even though there were some very world famous professors at

UCLA, both then and now. Although, I think—frankly, I think the ones we had were the best they ever had at UCLA. And but it was too theoretical and we both were not interested in computer modeling or that kind of stuff. We were both observational types. So got my master's in '67 and on a trip with Woodley and he was a private pilot. There was a trip that Bill and I and two other graduate students took to Key West in Bill's plane. And this was in September of '67, and let me think for a minute. Actually, hold on. I think our master's—yeah. We got our master's in '66, and then we started. After a year in the PhD program. Yeah. In September of '67. On this trip to Key West, we were flying back toward Miami and we had this encounter with a cloud line that spawned a whole series of waterspouts and I was an amateur photographer and always have been for many, many years. My father. That's one of the things my father did a lot of was photography. He even had his own dark room. So, which I've never tried to immolate, by the way. But he had some really good cameras and I inherited his Leica M3.

AW:
Red dot.

JG:
And I had also just purchased from Japan, a brand new super eight zoom movie camera. You know, that had the—and so I had both of these cameras with us in the plane. It was a piper apache aircraft. So we came upon this cloud line and started seeing waterspouts and we saw at least four or five and the last one was a giant one. I mean, a really big one. And so Bill circled and I filmed slides and movies and we were absolutely transfixed and the only reason we left was he was getting low on fuel. So we didn't know what happened to this big as it was approaching the key. The island. And so we went—we drove down there the next weekend because I think we had heard some reports about waterspouts in that area and so we started interviewing people and low and behold, it did come ashore. There were eye witness photographs and it did some damage, including lifting a Cadillac off the ground. Across the key. And continued again. Regenerated. And again, eye-witness pictures. So we were all very excited and my fellow graduate students said, "Hey. This is probably unique. You better copy right those photos," which I did, by the way. And we published some papers and at first, we all thought this was a once in a lifetime encounter that would never be repeated. I mean, we said that, you know? We said, "You better write this up. Get this out." So we wrote it up and I thought, "Gee. That was really interesting." And then I just sort of, you know, started. Went back to my classes and didn't think much about it and was trying to figure out what I was going to do for a doctoral thesis topic and then I came across a NASA scientist who had written a few papers about his experiments with the Navy in the Keys chasing waterspouts in sub-chaser aircraft that the Navy flew. And I thought, "Man. I better find out about this guy. What did he see?" And so I read his papers and his papers were his rationale in doing this was that he wanted to prove that tornadoes were driven electrically and so he wanted—he wanted to find waterspouts in the hope that they also were driven electrically and he could then, you know. So, and I don't know how he found

out that one could chase waterspouts with aircraft. But anyway, so he started doing it and he told me he saw a lot of them with great regularity and he had electrical instruments on board the aircraft. No other probes. No other measurements of the waterspouts or anything like that. Just, he took pictures and showed me, you know, and he had a few conference papers and I talked to him just like you're doing with me. And so I privately didn't think much of his theories, but I thought, "This guy is onto something." And so he was a very nice man. Very open, you know, not secretive at all. I've interacted with some secretive ego-type. Most scientists have big egos. In the case of Kishor Mehta, his ego is—he subsumes his ego and he is one of the kindest gentlemen I've ever met.

AW:
He is.

JG:
And I've met a lot of snake oil salesmen and ego maniacs in the field. Kishor is just that—he is the antidote to that.

AW:
Yeah. He is. In fact, as a—this is not—

JG:
So is Jim McDonald, by the way.

AW:
Yeah. I don't know Minor. But I know those two. But what—a sideline to this is another thing that drove my interest was I did—although, I never did finish my doctorate, I did graduate work in sociology at University of Denver and I was studying organizational sociology. And one of the things that is quite interesting to me is how Texas Tech's wind program developed as a counterpoint to a really star studded program we had in electrical engineering that was a top down driven and sort of was the—

JG:
Oh. Well I think the wind program we can attribute to the—what we used to fondly—

AW:
The Three M's?

JG:
Yeah.

AW:
Yeah, I agree.

JG:
That's it.

AW:
That's just what I was going to mention.

JG:
The Three M's.

AW:
Their personalities transcended the organizational drama of the university.

JG:
Well anyway, so continue on. All right. So Rossow's theories, I never—

AW:
Say his name again.

JG:
Vernon J. Rossow. R-o-s-s-o-w. Worked for NASA. I think NASA Ames in California. And I don't know how he got support to do this because—but see, in those days, NASA had a big budget and so their scientists were allowed to freely roam into other disciplines, like meteorology. And in fact, that at a time, we—at a time, we and NOAA [National Oceanic and Atmospheric Administration] were getting. How do I? We were getting—I don't want to say schizophrenic, but we were getting very jealous. Why? These guys are encroaching into our territory. You know, and so there was a lot of that going on between—a lot of back and forth between NOAA and NASA. NASA's getting into our, you know, our business. So, but Rossow was a very humble man, but you know, and he was very smart. Anyway, so he—I would say he was critical in my decision to pursue this. Absolutely. Without my talks with him and talking to him, again, I would never have pursued this. We all thought that this Matecumbe Key encounter with the aircraft was a one shot, once in a lifetime, never happen again. And then so after the interactions with Rossow, I began to seriously think about this and so I talked to my major professor, LaSeur, and he was supportive and at the time, I was working part time at the hurricane center. And now, the other two critical people, which had major, major impact throughout the rest of my career, by the way. Both as friends and as mentors, were Bob and Joanne Simpson. The dynamic duo. The original dynamic duo.

AW:
J-o-a-n-n-e?

JG:
Joanne. J-o-a-n-n-e. Joanne Simpson and her husband, Robert Simpson. They actually first met—their romance started when Joanne was our major—was a professor. One of my professors at UCLA and Bill Woodley [Phone chimes]. And Bill Woodley actually went to work for her in Miami when she moved from UCLA to Miami and then she and Robert Simpson were married and they both worked at Miami [computer beeps]. So I worked for her husband and Bill Woodley worked for Joanne and so all of us interacted throughout the rest of our careers and even beyond. I mean, interacted strongly. And so the other absolutely critical person, mentor, to me in pursuing waterspouts as a study and later, tornadoes, was Bob Simpson. He went—anyway, so he gave me comp time, it was called, for my forecasting shifts to organize and carry out my field projects in Key West. And you know, and like I said, so while it started as serendipity, I had a lot of serendipity subsequent to the original accidental encounter. It was all, you know. And so anyway, so a lot of the rest of it you'll get from my papers, but I organized. And Simpson also went to one of his friends Ed Kessler, who was the director of the Severe Storms Lab in Oklahoma and on my behalf, asked Ed for a grant. A small grant of money to support my field program. In other words, Bob Simpson used his own charisma and friendship with Ed Kessler to get a grant for me and it was not very big. It was like, I think, ten to fifteen thousand, but boy. I got more bank for the buck I think than Ed Kessler ever got for that kind of money. [Phone chimes] So—and Kessler was very skeptical, by the way. Understand, he never knew—he never met me and it was only Simpson's charisma that convinced Ed that I was onto something, but Kessler was very skeptical and so he, you know, he was—that's why he didn't give me more money. He thought, "Well, this kid. You know, if he loses it. Maybe he'll get a little bit of weather data around the Keys." And so I did a lot of—and I talk about this now, ironically, on cruise ships. I lecture on cruise ships. I get to reminisce.

AW:
So you get to take a cruise.

JG:
And I lecture.

AW:
And you lecture on the—

JG:
And I reminisce about a lot of what I'm telling you, but without any of the—more pictures and not so much detail. So I talk about things like Rube Goldberg, which none of today's young

people have any clue about.

AW:
I know it.

JG:
But you know, it's trial and it's the ultimate form of trial and error and boy, did I use a lot of that. All right. I tried all kinds of crazy stuff and I don't have the time to go into it all, but I'll give you one or two examples. But anyway, so I got more bang for the buck out of that ten to twelve thousand dollars probably than anybody has ever seen because I also literally begged, borrowed, and stole from the people down there in Key West, especially the Navy. So and by the way, I still have great affection for the Keys and all the people that live there. They are just fantastic [computer beeps] and it just breaks my heart, you know, after what happened last year with Hurricane Irma. They're still recovering. Fortunately, Key West itself was on the weak side of the eye. There was a lot of damage, I'm told, a lot of damage to home owners up the keys, especially, Big Pint. So I organized. I had—my first contact with Rossow was in '68 and I got to meet him at a conference too. So I actually—yeah, so I actually got to talk to him face to face and he was very open. This was Key. I mean, you know, if he were one of these dilettantes or ego maniacs, you know, he would've cut me off. That would've been the end of it, but he wasn't. He was—and even though, I'm sure he sensed that I was kind of skeptical about his electrical theory on tornadoes, he was still very open and he showed me his files and man, it obviously flown around many waterspouts and gotten the Navy to do it. He said the Navy—I guess he'd heard that some of the Navy pilots had seen waterspouts and so that's how I guess he sort of decided to organize his own little project. Rather than—he sensed it would be a lot safer and he'd get more data than he could ever hope to get tornadoes. Flying around tornadoes.

AW:
Oh yeah. Yeah.

JG:
So.

AW:
Well you'd think the Navy would be interested in waterspouts.

JG:
Well yeah. And that was, I'm sure, part of it. So he got quite a few cases and some of them were quite large. So I thought, wow, you know? And I think, at first, I was hoping to get help from the Navy and I did get some, but I had no contacts. No way of seeing about getting aircraft support from the Navy so I did—but then I started talking with some fixed based operators in Key West,

you know? And I came across the airport manager there and it's really weird, the things I remember, the things I forget. Seriously. His name is George Faraldo. F-a-r-a-l-d-o. George Faraldo. He was the airport manager at Key West. Also, a private pilot. And so he and I started having chats and much to my astonishment, he started bragging about all these waterspouts that he had already flown around. I said, "What?" He said, "Oh yeah. They're all around here all the time in the summer."

AW:
Yeah.

JG:
And so I cut a deal with him and I'm sure he gave me a discount because—anyway, because he knew I was on a limited budget and at first, I was apprehensive because I was wondering, how is he going to get away to fly? How is he going to get away at a moment's notice? Because I told him, I'd really need—you know, we'd need to be prepared. He says, "Don't worry. We'll work this out." And then when we actually got up and started flying, my only real moment of terror was in some of these early flights where he'd go up and we'd swap these waterspouts and he'd say, "How close do you want to get?" [Laughter]

AW:
Yeah. I think I'd have a little trepidation about that too.

JG:
And I said, "Not too close, George. We want to see how close we can get safely." Because I was beginning to think about, well, you know, what kinds of experiments can we do safely? You know, like tracer experiments to get air motions knowing that I had to do this on a cheap—I didn't have any real instrumentation. No instrumentation other than the temperature gage on the aircraft, you know? And so he, yeah. I mean, he, and his experience was invaluable to me because this was my first time and so anyway, we learned. It was a very rapid acceleration of learning, just being with the man. And to this day, this was another key individual, you know? I was just so lucky throughout all of this and the other thing was I had made very good friends with the people at the Key West Weather Service Office and so they were interested and they allowed me to hang out there a lot and I set up a time lapse camera. Super eight time lapse camera that I—Jerry-rigged. I got the mechanism, I forget, from somebody to take—make time lapse. And so I had a friend there. His name was Jerry Clemens, in the weather service, who was sort of my—became my good friend and local spark plug there in the Key West office and so he and his colleagues would turn—even when I wasn't there because I couldn't be there all the time. I said, "Anytime you see any interesting cloud lines, or especially, if you see any funnels, turn it on. But even if they're not funnels at the time, just turn it on. Let it run. Film is cheap." So the other thing he did, Jerry Clemens did, is we organized and I don't think it's ever been

replicated, we organized the spotter network for calling them waterspouts. We had about thirty volunteer observers and Jerry did most of the work. He went out. He knew people and talked to people. He said, "Call us. You see anything, call us." And they had never had that at the local office before and I don't even know, to this day, if they've ever repeated it because it took a lot of work and a lot of—literally, a lot of leg work. But we had a thirty station network of people that called in. So jump ahead to the end of the project in 1969. I had more data than I ever dreamed I'd get. I mean, it was—and we documented, just with the aircraft, a hundred waterspouts, all—most of them within a twenty-five nautical mile radius of Key West. Hundred waterspouts from the aircraft. Just from the aircraft. And then, if you add in all the public reports, including the spotter network, and I'm not reluctant to brag about this. This is what makes Key West the water spout capital of the world. In that one year, we had five hundred waterspouts.

AW:
Wow.

JG:
Five hundred. So in my shipboard lectures, what I tell people now is that Key West is the water spout capital of the world. Nobody has been able to refute that or offer any other places that come close. In a typical year, because that year that my experiment, which was the year I was married by the way. My wife was a water spout widow for the first two months of our marriage. Quite literally. There was nothing unusual about the weather patterns in Florida that year. So I tell people, "You should expect in the lower Keys to experience between a hundred and five hundred waterspouts every summer. One hundred to five hundred waterspouts every summer." And nobody has refuted that and I don't think they ever will. That doesn't mean that we always get a hundred reported because a lot of people, the long-time residents are so used to seeing them, to this day, they don't call them in because there isn't any spotter network going.

AW:
Just for my edification because I just don't know about this. Is Key West unique in that worldwide? Or is that where you happen to have the information network?

JG:
Both. One of the things in my doctoral thesis that I was able to show that it is the unique geomorphology. Geomorphology of the Keys. The fact that you have this long chain of island that in the summer months, is nearly parallel to the low level east to northeast winds and you have a very efficient heating mechanism. It's a very efficient differential heating mechanism. The water temperatures in this shallow water that surrounds the Keys, both north and south, the water depths over a large area are less than two meters deep. I measured skin temperatures on a sea surface in the low nineties. Many often.

AW:
Really? Wow.

JG:
Yeah, it's in the low nineties. So what happens is you get this differential heating mechanism and frequent formation of these rapidly building cumulus cloud lines. Those are what spawn the waterspouts. The cumulus cloud lines. Now, there's a lot more to it that still needs research as to why—how do you get the spin ups? One mechanism appears to be these shower outflow boundaries that develop and that combined with this differential heating mechanism, we see rotation in the cloud bases on the time lapse, which I have, which is very common. I mean, they got some time lapse almost overhead. You can see the cloud base spinning and the funnel come right down. This is long before Doppler radar. You could see the cloud base rotating and then the funnel just drops down. So it happens there with great frequency and I think it's all these combinations of the chain of islands, the different—the shallow warm water, the differential heating mechanism that causes so many waterspouts there. You get waterspouts and I show examples from many places in the world now. They also get them quite often in the Great Lakes in the transition seasons and that too is caused by heating from below. Although, I mean, they even get it in the dead of winter, but there are times in which the lakes don't freeze over and you get very cold air that comes over them and you get these short live waterspouts, but I've got some pictures of waterspouts even during the summer. Big ones, in Lake Michigan.

AW:
Wow.

JG:
So they do get them. They do get them up in the Great Lakes. Again, more often than we used to think. We used to think that they were very infrequent, but I would say after the Keys, the Great Lakes gets quite a few of them. Surprised.

AW:
That's interesting.

JG:
And I've even had—I have slides of some really big spouts up in Canada. Southern part of Baffin Bay. Up, you know, Northern Ontario. Northern Quebec. They've had waterspouts off the lake that far north.

AW:
What are the wind speeds in these sorts of waterspouts? How do they compare with tornadoes?

JG:
They can be just as intense as an EF1 or EF2 tornado. I've measured wind speeds. You know that movie that I told you that I took with Woodley? That was analyzed in my doctoral thesis and we found wind speeds in that Matecumbe case of eighty-eight meters per second. Just over two-hundred miles an hour. In the spray. In the spray vortex. So they can. There's no question that waterspouts, the bigger ones, can have wind speeds at the surface, very close to the center an excess of two hundred miles an hour.

AW:
Yeah, wow.

JG:
So they'll produce tornadic damage if they come ashore.

AW:
Yeah. Yeah. Yeah.

JG:
So anyway, so and then I moved in 1971, I had a critical juncture in my career where I'd have to decide, you know, do I want to continue in hurricane forecasting or do I want to get into research and finish my doctoral dissertation because I had this ton of data and would be many years if I continued forecasting and I'd have to do it all in my spare time and so I talked to Bob Simpson about it and so he talked to Ed Kessler again and so Ed agreed to take me on.

AW:
With the center in Oklahoma?

JG:
Yeah. And again, I don't think—how do I put this? I think it was Simpson's charisma that convinced Ed that I would be a good young scientist for him to add to his lab because I could sense from the moment I got there that Kessler was very skeptical about my work and very skeptical that I produced very much in the way of referee publications. Understandably. But in fact, Ed Kessler once told me he—I'll never forget this—he said, "Joe, you've got to curve your unbridled enthusiasm." I'm quoting him directly.

AW:
Yeah. [Laughter]

JG:
And so—luck—but I chose to ignore that advice.

AW:
Yeah. Good for you.

JG:
[Laughter] But so we had—there was always this dynamic tension with Kessler because he was a theoretical. He was a theoretician. He got his—

AW:
Really?

JG:
Yeah, he was from MIT.

AW:
But it's interesting a theoretician would be at the storm center.

JG:
Yeah. Oh yeah. Yeah. Oh yeah. But anyway, I mean, so I owe a lot of my career to Kessler even though he gave me—even though he rode me pretty hard, as you say in Texas. Kessler rode me pretty hard. So and then the other thing, which I'll touch on, is another—this was another case of serendipity. A lot of people assumed that I started chasing tornadoes at NSSL [National Severe Storms Laboratory] on my own initiative. You know? That it was all my idea and that I—it was something that I wanted to do right from the beginning. That's not true. It was Kessler again who came to me with this proposal that he'd gotten from a Notre Dame engineer. Okay. We'd never heard of him before. Named Professor Bruce Morgan. And Kessler showed me this proposal and I talk about this briefly in my cruise lectures because it is so far out, as John Denver would say. Anyway, so Kessler showed me this proposal and he said, "Golden, I want you to look at this. I think this guy might be onto something. This engineer, he's looked at the storm data and he's done what I think is some decent homework and he is showing that if you have a van, an instrumented van, with radio communication to the radar operator at the laboratory, that the scientists, if they're meteorologists on board with this engineer, that they'd have—his data suggests you'd have a 60 percent chance of intercepting one tornado a year. So he says, "Golden, I want you to look at that." So I did and I thought, hey. Maybe this guy's onto something, but he also, in part of this proposal, which is even more amazing. And I have to tell you, this proposal was the butt of many nasty jokes during coffee breaks. I mean, most of my colleagues in the lab thought this guy was nuts. The other part of his proposal, which is even more amazing in light of what's happened over the last decades was that his idea was that once we intercept a proposal, we would have an instrumented armored personnel vehicle on a back of a flatbed truck and the APV [All Purpose Vehicle] would have, presumably, Notre Dame graduate students inside and there would be ruggedized instruments. Ruggedized instruments, you know, that could take

debris impacts and measure wind, pressure, temperature in a tornado. Inside a tornado. In other words, you'd get this in front of the tornado, deploy the APV, and then drive away and leave the APV to go enter the tornado. I mean, you have any idea? I mean, we're talking about, you know, fifty years ago.

AW:
Yeah, that is amazing.

JG:
And so I actually have the original proposal and I have slides from it. It's just my—they're doing it now and I think—most—some of them that are trying to do it are totally—they're nuts just as I thought it would be nuts to try it then.

AW:
They are. I have coffee every morning when I'm on campus with a guy whose day job at the campus is public radio, but he's a storm chaser and so he's nuts.

JG:
Okay. Yeah. So anyway, so I show these slides. I show these. They're drawings from his proposal and I mean, that part of it almost killed it because the other scientists in the lab were trying to, you know, lobby with Kessler. Don't let him—you know, don't give this guy any money. You'll never—you know? And I—so long story short. I was filled with—I had conflicting feelings about it because Kessler—and I didn't volunteer. That's what I try to tell people. I never—this was not my idea. I didn't volunteer. I was directed by Ed Kessler to be the cognizant scientist. I told my wife about this and she rolled her eyes and I know she wasn't very happy either about the risks of doing this. So I get a lot of the credit, but I don't deserve a lot of the credit. Most of the credit goes to yet another engineer that I've interacted with over my whole career and throughout my whole career, it's the engineers that have sort of led the charge on many of these key problems in severe weather because we, meteorologists, are a nutty bunch and you know, at times, we're afraid. Yeah, understandably, we're afraid to take risks because we get burned on bad forecasts that happen. Things like that.

AW:
Yeah.

JG:
But so frequently, it has been—throughout my career, it's been the engineers that have led the charge on tackling these key problems. So if there's one thing I want you to get out of all of this is that I have been so lucky to have mentors and colleagues that have not been afraid to take risks because the one thing you find in government is overwhelmingly, is that people above you are—

and we joke about this in meteorology. The people above you are often CWA. Do you know what that stands for?

AW:
It has to do with—

JG:
Cover your ass.

AW:
Yeah. I was going to say covering a significant part of your anatomy.

JG:
Yes. Cover your ass. So don't take risks or you're going to get in trouble. Don't take risks. You lose your money. So anyway. So I've been very lucky because I've been associated with people that have been willing to take risks and in most cases, they've succeeded and so this tornado chase program, I thought, well maybe, you know, it'll last a year and then Ed will decide not to fund it anymore and I'll have to do something else, but it gradually took off and after—we had a few successes. We didn't get a lot of data. We did intercept a few tornadoes, but then we had a really—a breakthrough case and that was Union City, 1973. And that was—turned out to be another defining moment in my career after the water spout studies is that the Union City case—another case of serendipity. Everything came together. All right? After having some successful tornado intercepts, but mostly at outer ranges of the radar and many, many failed—you know, many missed cases where we would be approaching a storm and it wouldn't produce a tornado or it would produce a tornado and we were too late. And unlike today's chasers that now, can get radar data on their iPhones. It's important to emphasize we only had—we had a van that used single side band radio and that was the communications, which meant we had to be within range of a repeater station in Oklahoma. We had a big book of maps. Of section road maps. You know what those are?

AW:
Oh, yeah.

JG:
Well it turns out they were frequently wrong and we'd be going down a dirt road and come to a dead end on a creek or a river and big storm, you could see, it looked like it was spinning and that was the end of it. We couldn't go any—or we got stuck. We got stuck in the mud so very frustrating and we'd frequently be out of range. In fact, at my retirement, a luncheon at NSSL, with friends like these, who needs enemies? But one of my friends that I keep in touch with, he's still in Kansas City. Jim Henderson played a tape that they'd recorded of some of our

communications and you'd hear him yelling. You know, he'd say, "You're saying hook echo right over us? Where?" [Laughter] Of course, trying to embarrass me, which they did.

AW:
I was a police officer in Lubbock in the sixties and later, in Lakewood in the seventies. But in Lubbock, I was there for the May 11th tornado of 1970.

JG:
Oh, you were?

AW:
Well the smartest thing I ever did in my life though was I had taken that day off to get some wisdom teeth cut out because my duty station would've been right downtown where some of the worst damage was. So I was back to work shortly thereafter, but it was a very active season and a couple of weeks later, we had a—and my job—one of my jobs as a traffic officer was to be a tornado spotter because what you're saying about the weather data is exactly right. They would send us out to predetermined spots and we would report back wind direction and relative speed. Hail size and all that sort of data, but I had a hook come over the top of my patrol car and they were calling me and saying, "There's a hook at certain certain location," and there I was.

JG:
Oh my gosh.

AW:
Yeah. Oh my gosh is correct.

JG:
So anyway, so and again, I get into the—

AW:
So back to Union City.

JG:
All right. Union City. What makes it important? Everything came together. All right. We intercepted the storm after going out in western Oklahoma. Squaw line and so forth. And then we raced back east because there were signs that there might be some super cells developing out ahead of the squaw line. And again, serendipity. But the people at the lab, you know, I would be—try to keep in frequent contact. So everything hinges on right decisions. You know? And you only know after the fact if it was a right decision. Anyway, so my gut said, "Turn back. You're not going to see any tornadoes in this squaw line." So we headed back and just—they

were just starting to get some echoes west of Union City so we got on the storm early.

AW:
For the recording here, give us an approximate coordinate of Union City.

JG:
Twenty-six miles west-southwest of Oklahoma City. Twenty-six miles. I think that's right. West-southwest of Oklahoma City and west-northwest of Norman. All right. So we got in position and we started seeing what I had already began to understand from our own observations and Fujita's work, by the way, a wall cloud. Rotating wall cloud. I thought, ah-ha. Maybe we're going to have something really good here. So we set up eighteen miles. I think it was eighteen miles south of Union City. We said, "All right. We're not going to move." So we watched this wall cloud. There were two or three funnels that came down and then they went back up and so we filmed for the first time ever. There had been other tornado movies like at Dallas that had filmed close up to get wind speed estimates like Walter Hecker found, but no one had ever documented the whole birth—the whole life cycle of the tornado like I'd already done for waterspouts and so we filmed. We had, by the way, we had some movie cameras that were on loan from NASA Houston. We had the best equipment you could get and again, from my Keys experiences, you know, I learned to beg, borrow, and steal. And so NASA, I got the scientists at NASA Houston to loan us these Apollo cameras and I had my own super eight still and I had my Leica and so we filmed from beginning to end and got the life cycle. But the thing that made history and this made the top ten, by the way, this event made the top ten scientific breakthroughs in NOAA, my parent agency, on its hundredth—on its bicentennial celebration a few years ago. This event, the Union City tornado, and the work that the laboratory did on it. You know, my leadership, I'll make claim on this one. Made the top ten scientific breakthroughs in NOAA throughout its history and so the key thing, in addition to documenting the first life cycle of a tornado was that we also were in constant communication with the lab because we were close enough, within range, of the single side ban, et cetera, et cetera. So the lab was scanning the storm throughout the history of the storm with its Doppler radar. It's single researched Doppler radar and they were able to detect a mesocyclone and a tornado vortex signature. Those were both discovered from this event. Later, scientists at the lab told me that without our three dimensional structure. You know, photographic analysis of the tornado and the storm, they might have thrown the Doppler data out as bad data without having our observations because it looked so strange. Nobody had ever seen anything like this. In other words, they saw the development and evolution of this mesoscale, what's called a mesocyclone, prior to the tornado itself touching ground, and then they could pick out within that a signature for the tornado itself on the Doppler data, and so that led to NEXRAD **[Next Generation Weather Radar]** basically. That event led to other projects that proved that it wasn't just a one shot deal and that led to the tri-agency NEXRAD program and the deployment of Doppler radars all over our country. So yet another case of serendipity. And the credo of all storm chasers now, even these days, is you got to be

smart and you got to be lucky. You got to be smart and you got to be lucky and as a post script, I've always been worried about the dangers and unfortunately, we've had chaser deaths. And one of the worst was an experienced—an expert storm chaser, Tim Samaras and his son and their colleague, Carl Young, that died in this record breaking 2013 tornado near El Reno.

AW:
I remember that.

JG:
And that just—that shook me to my core. That's the very thing I've been worried about all these years and I never thought it would happen to an expert. I always thought that it would be some yahoo.

AW:
Yeah. Well and then most recently, the one I remember was two car loads.

JG:
Yes. Yes. West of Lubbock. And that should never have happened. But so anyway, so that brings us up to date and I went chasing actually with Tim Samaras. I helped him get his first government grant and I went chasing with him after we moved back here in 2005. That year was a very lean year.

AW:
You know, well answer a question for me on that. One of the things that even in the seventies, we were—this was just our observation because at that time, Lubbock was right in the thick of the tornado alley. You know, we had lots of them. Growing up on the farm, especially, you know, we'd stand out and watch them because it was so flat out there. But after we had the May eleventh tornado, we had a very active season that year, one of the things that we recognized and I don't know where the information came from, but we learned that you could be looking at the tornado here and there's one about to drop down behind you. Is that the kind of thing that happened to Samaras?

JG:
Nobody knows. There were people. There were chasers close by. Most of the other chasers began to sense that the storm was a very unusual and erratically behaving—not your typical tornadic storm. Didn't fit on the model. Didn't fit any of the models. They sensed that and they backed away. Samaras stayed close to it and they just think he lost his situation awareness because of the size and rapid intensification and the unusual emotion of the storm itself. The storm made an unusual turn and they think that Samaras just lost his situation awareness and that he and his son and their colleague were caught unawares by a suction vortex. This tornado was

two miles across. Broke all records. And the other chasers did see suction vortices in it and those can be very intense and they can spin up very rapidly so they think he just lost his situation awareness. But nobody knows for sure. And they found—they found his Chevy Cobalt a half mile from where it had been parked and it was just crumpled. The other two occupants had been ejected and died and Samaras was still inside the—I think he was still inside the vehicle with his seatbelt on.

AW:
Yeah. That's a pretty small automobile to be dealing with that.

JG:
Yeah. And it was just—just.

AW:
You know, that—the—again, the May eleventh tornado in Lubbock in '70, it got key shore.

JG:
Well this is what started the whole wind engineering. This is—Fujita came and Fujita did his analysis and it started, what I would call, some dynamic tension between the wind engineers and the meteorologists, which—what it means is, were there fights? Yes. Were there disagreements? Yes. Some of them, very intense. But it started this whole process of dynamic interaction between the meteorologists and wind engineers, which thankfully, continues to this day and one of the great things that's come out of it is even after Fujita's death, the meteorological community recognized they needed help in revising the F scale because of this disconnect of the wind speeds, especially at the upper EF ranges and so I think we've come up with a new scale that's much improved and you know, that both sides have most agreement on. So I think that's about it. I can—

AW:
Yeah. I think if we have time to go look a little bit at the materials.

JG:
Sure.

AW:
But real quickly, how did you wind up in Boulder?

JG:
Oh my. If you work for the government, you're going to—either you move or you stagnate. So I've lived in—started in Miami, moved to Oklahoma, and then after completing my dissertation

and showing and having some success in the intercept project, I had an offer to come to Boulder, here at headquarters. So and that was another—I knew it would take me having full-time for research. I continued some research, but it was mostly in the programs office here and then I had an offer from the weather service to come work at weather service headquarters in D.C. and we moved there in 1984 and so I was there for fifteen years with my family kicking and screaming, by the way, when we left here. But you know, and so worked—the first part of it, I worked at weather service headquarters as a manager and then I transferred to OAR, to the research headquarters and then I had—finally, I had an opportunity from Sandy McDonald to move back here to, what was then the forecast systems lab and that was 2000. And so it's been a varied career, but we love it here, obviously so I took the offer from Sandy and enjoyed working with him here at the forecast systems lab, which is now called Global Systems Division. So if you work for the government, many—most people have to move to get, you know.

AW:
Yeah. Well I'm going to end it here so we can go look at that material and say thank you for the time.

JG:
Sure. And as I've sometimes told people—

End of recording