Warren Washington Oral History Interview, May 29, 2015

Title
"A Pioneer of Climate Modeling"

Date
May 29, 2015

Location
Washington residence, Denver, Colorado.

Summary
In the interview, Washington discusses his parents' backgrounds, his upbringing in Portland, his memories of Portland's African American community in the 1940s and 1950s, and his early involvement in civil rights issues.

From there he describes his decision to attend Oregon State College, his initial impressions of OSC, and the racial climate that he observed on campus at that time. In reflecting on OSC, Washington outlines his academic progression, sharing his thoughts on the Physics program and the early computing resources then available. He also speaks of his social life while an undergraduate, including his contacts with African American student athletes at OSC as well as those travelling to Corvallis to compete.

In rounding out his memories of Oregon State, Washington describes the various jobs that he held while a student, including maintenance work at Good Samaritan Hospital, operating a radar apparatus at the tops of Marys Peak, and repossessing cars with his brother during the summer. He likewise reflects on his earliest interests in meteorology, his OSC graduate studies, and a collection of mentors that aided him during his years in Corvallis.

Washington next touches on his doctoral studies at Penn State before moving on to his first association with NCAR, speaking of the center's growth - including its physical architecture - and the early work that he conducted there. In particular, he describes his research on Indian Asian monsoons and early conversations that took place on the subject of climate change. He also recalls his first contacts with the Carter administration, his experiences advising four subsequent presidential administrations, and the complications that he encountered while trying to maneuver in Washington, D.C. As asides, Washington also describes his co-authorship of the textbook *An Introduction to Three Dimensional Modeling* and assesses the impact that it made, and likewise touches upon his co-founding of the Black Environmental Science Trust.

As the session nears its conclusion, Washington shares his memories of the awarding of the 2007 Nobel Peace Prize to the Intergovernmental Panel on Climate Change, and the reaction that this announcement elicited at NCAR. He also describes his own experience of receiving the 2010 National Medal of Science from President Obama. The interview closes with Washington's thoughts on and concerns about the future of a warming world.

Please note that this interview includes remembrances of a culture of racism and the use of racist, derogatory language toward African Americans, including the N word.

Interviewee
Warren Washington

Interviewer

Website
http://scarc.library.oregonstate.edu/oh150/washington/

Transcript

Chris Petersen: Okay, today is May 29th, 2015 and we are with Dr. Warren Washington in his home in Denver, Colorado. Thank you very much for having me Dr. Washington, I really appreciate it.

Warren Washington: You're certainly welcome.

CP: So, we'd like to talk a lot about your upbringing in Oregon, your Oregon State experience, and we'll talk about your career as well. I'd like to start with your parents a little bit, if you wouldn't mind giving us a sense of their background, your father and your mother?

WW: Okay. My father went to an African American college at that time. He graduated 1928. It was Talladega, outside of Birmingham. And he almost immediately left there and went to Seattle and Portland Oregon and settled down there and met my mother there. My mother has an interesting history. Her mother came from Texas in a small town called, I think it was called Weatherford Texas. And she came from a family of sixteen children, and one of the children, the oldest, went to the Lewis and Clark expedition celebration in Portland Oregon, I think in 1904. And he thought it was cool, compared to Texas. And virtually all of the family moved out to Oregon, and I have some pictures in my autobiography showing this very large family which was—and that picture was taken in 1930 in front of the Bethel Amity church in Portland, and it's where the basketball arena is now. I remember that church because we went to it every Sunday, and it's just kind of a shame that it was displaced, but urban renewal has that aspect.

The importance of all this is that all of my brothers, and my mother's two sisters and brother who went to college, my mother went to the University of Oregon in Eugene, Oregon. But at that time, African American women students couldn't live in the dormitories, so she had to live with a family acting as a maid. And so, I think that she went for maybe a year and a half or something like that, but it was an awful situation for her because the people weren't very caring for her, so she never actually finished college, except that she, after she had raised a family she did go into nursing and became a practical nurse. And so, I came from a family of five boys. I'm right in the middle. And we still have two younger brothers living in Portland.

CP: What was the attraction of the Northwest for your father?

WW: I'm not sure. There was a very complicated situation with my father, because I'm not sure who his mother was. We do know that there was—my grandmother had a sister and we think that that may have been his real mother. And she lived kind of a fast life. She knew the boxer Jack Johnson and traveled with him, and she lived at that time in Seattle, so when he left he went to initially live with her, as far as I understand.

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But the family never talked much about this. And in fact, my father, there was some question about his name, because we knew him as Edwin Washington, but when I visited out at Talladega to give a talk—I give lots of talks around the country—at the end of my talk I went over to the library and I asked "could I look at the 1928 yearbook?" I told the librarian his name was Edwin Washington and she came back from the archives saying "there was no Edwin Washington graduating 1928." I said "well, can I look at the yearbook?" and I thumbed through it, and it was a small school, and there he was, his name was George Washington. And I later learned—so I asked her to make a copy of that and I sent it to my father along with my brother, and in somewhat of a humorous way I said "Dad, you've lied to me all my life, your name was George Washington." Well apparently, what he did was he didn't like George Washington, for obvious reason, and when he went to Seattle one of the first things he did was to officially change his name from George to Edwin.

CP: What line of work did he find in the Northwest?

WW: Well, he graduated, as many African Americans did in the late 1920s, and they couldn't get jobs and use their educational skills, but they often went and joined on the railroads. And if you look historically with the African American men, it was a place—and in fact, my mother's grandfather worked on the Southern Pacific going from Oakland to Portland, and he got a job on the line that went from Portland to Chicago and back. And as it turned out, most of the

waiters who were on there were college graduates. I suppose they felt that they could be polite and be informative-type people working with the clientele on the trains, in the dining cars.

But it was, on the positive side of all of this was that they were able to make enough money to raise a family and to send their kids to college. So, it was a good enough salary with pension benefits that it would—it was a good life.

CP: Do I understand that he had an interest in science, your father?

WW: Yeah, for some reason he developed, I think he graduated in history from Talladega, but later in life he got interested in astronomy and he would set up a little tripod in the evenings in the summertime out in the front or on the sidewalk in front of our house and look for the planets and the galaxies. And he, I mean it think it was just a hobby sort of thing. I remember him coming back in the house and saying "come out here, I see something I want to show you." And so, I don't think that that was a big factor in me deciding to go into science. I think that came from other interactions with high school teachers.

CP: Well, you were born in 1936 in Portland, and what neighborhood did you live in, where did you grow up?

[0:10:02]

WW: Well it's interesting; we grew up on a place on Roslyn Street, which was half a block from Union Avenue, which is now called Martin Luther King. And it was a mixed neighborhood. I went to Highland Grade School. I would say a very small percentage of African Americans lived in the neighborhood, but they were very prominent people. For example, there was a, just a few houses down there was a Dr. Randalls who, I think he's still alive, but he was the first African American doctor who was educated at the University of Colorado medical school. And then somewhere in the 1940 time he was here. And in fact, they named something after him, I forgot what it was. And then there was a Berry, I forgot his first name, who established the Urban League in Portland Oregon. He was living up the street from us.

And eventually that house was turned into a Fred Meyer parking lot, or at least part of it, as it expanded over the years, because it's close to Killingsworth and Union Avenue, or Martin Luther King. And so, they moved, I think sometime in like the early 1960s to a place just off of Alberta Avenue. I have two brothers who were still living in that house, which actually, the value of the house has gone up enormously because people want to live close to Alberta these days, which kind of went through a period of disrepair and now it's coming back.

CP: Yeah, I'm sure your brothers have seen a lot of change.

WW: Yeah.

CP: Well, what was Portland like as a community for you, growing up?

WW: I think it was good. The school was good, we had both undergrad—I mean elementary school and a high school. I don't remember anything particular about the elementary school, except that I think I got the fundamentals. High school was quite different. I went to Jefferson High School and I just, I learned at some point that I was pretty good at mathematics, algebra and trigonometry and so forth, but my real turning point into science was my science teacher. I think her name was, it's in my book, Pebbles...yeah, I can't remember her last name. But she was just fantastic in chemistry.

She would never tell us the answer to something. She would say "well, why don't you look it up?" And there's this phrase in my autobiography where I asked why egg yolks were yellow. She says "why don't you find out?" And so, she had us all buy a handbook of chemistry book, which is almost like, at that time, an encyclopedia of what was known about chemistry. And I did look it up and found that there's a yellow in egg yolks that probably came from various sulfur compounds that were in eggs, and you can trace that back to the grains that chicken and so forth eat. So, but it was kind of exciting to me to kind of find something out and not just listen to somebody giving me an answer. I think the process was important. That was in my junior year, and then my senior year there was a physics instructor called Mr. Woods and he was fantastic also. So, those two individuals probably had more to do with me deciding when I went to Oregon State that I'd go into science. And then I ended up going into physics.

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Now one of the interesting aspects is how I actually got there. It was a little interesting little story. I was working in my senior year at the Good Samaritan Hospital washing dishes. And it's a good job, I think I made almost, I think seventy-two cents or seventy-eight cents an hour or something like that, and I was able to save up enough money for a car and for the insurance for the car, because being a teenager, you had to get insurance. And one day I asked the dietician if she can give me some advice on where I should go to college and she said "oh, we have a Good Samaritan Hospital in Corvallis, do you want me to see if I can get you a job there?" because at that time tuition was forty-seven dollars a quarter. It was a different ethic than we have nowadays where, you know, the ethic then was to make college as cheap as possible so anyone who was qualified could apply and get into college and go to school fairly cheaply.

Well, she immediately went and called up to the dietician at the small hospital that was in Corvallis at that time. I don't remember how many beds it had, but it couldn't have been more than thirty or forty beds. And they were looking for a handyman kind of guy. So, I had to not only wash dishes, but move patients, because I was the only male around in certain hours of the day, and keep the furnace going. And so, I worked a few hours every day and was able to go to college. So, the decision about where I went to college through a lot on the fact that this dietician found me a job there.

But I kind of knew that I wanted to go into physics. And the way that I learned that was that there was a library that my mother took me too, even though I was a very young kid, on Killingsworth Avenue close to Jefferson High School. And one of my prized possessions was a library card and I'd go and get books on things like physics and chemistry. But I liked the biographical books, like Einstein and other scientists and engineers, and I finally learned a little bit about George Washington Carver, who was a very prominent scientist, African American scientist. And reading the biographical information was exciting for me, because he had shown that these people came from ordinary backgrounds. So, I got the feeling early on that I could do it; there wasn't the fact that they were wealthy or that sort of thing. It was that they came from ordinary backgrounds and eventually became prominent scientists in their fields. And I think that was another reason why "gee, I can do this," I got that attitude.

CP: You mentioned that you grew up in a mixed neighborhood; I wonder were there contexts in which kind of the larger African American community came together? Perhaps, you mentioned church, was that an instance where it was—

[0:20:02]

WW: Yeah, yeah church. And then, at the time that I was in high school, one of my best friends then, and even now, is Billy Rutherford. His mother and father were the president of the NAACP, president and I think secretary of the local chapter of the NAACP. And they were pushing for public accommodations laws, because at that time—that was in the early fifties—there was discrimination at certain restaurants and hotels and motels. And through the efforts of the NAACP and other organizations and some of the local politicians at the time—Hatfield was one of them—the legislature eventually passes a public accommodations law to outlaw that sort of discrimination.

So, I had some very minor part in it, because I was the vice chair of the Junior NAACP. It was kind of like an affiliate, to have the young people engaged. I'm not sure that we did very much other than play basketball and do some other things, but it was a way for them to draw in the younger people into the early civil rights struggle.

CP: Yeah. So, the civil rights issues were on your radar at this point in your life.

WW: Yeah, although it wasn't like I was not able to kind of function, because I don't think that we had a lot of direct discrimination. I should point out, though; it was years later that my mother told us that after my father bought the house, he sat out in the front of the house with a gun, because there were a lot of angry people about moving into the neighborhood. So, there was hostility in the neighborhood, but I think by the time I was growing up I didn't really experience a lot of it, although I remember being called "nigger" all the time by people in cars, mostly. I think my parents prepared us for that sort of thing happening, so that they made us aware just to avoid those kinds of people as much as possible but not try to engage them.

CP: Well, we've covered the reason why you went to Oregon State, but I wonder kind of what your first impressions were once you arrived. Had you ever been there before?

WW: Well, I actually had visited there sometime in the fall, or in the summer, just to stakeout the place a little bit. I was very favorable that they had some kind of pre-orientation thing that there is, to incoming students. My interesting and almost humorous interaction was on the first day of school. I moved into Weatherford Hall. Is it still called Weatherford?

CP: It is, yes.

WW: Yeah. And I got set up and so forth and then a few hours later another kid showed up and he was white and he looked at me as if he was wondering why I'm there. He was from Pendleton. It turned out that he had never spoken to an African American. He had seen them working in the fields and I don't know what they, they picked peas or something, or...

CP: In the general vicinity, yeah.

WW: Yeah. But he'd never seen one. But we got to be, we got along fine. And I never followed up on what happened to him, because he went into the, I think there's a branch of medicine which isn't the ordinary, orthopedic or ortho-something or other when you deal with bones and so forth, but you don't go through the normal medical school, you go through another.

[0:25:10]

CP: Osteopathy maybe?

WW: Yeah, I think that's what it was, osteopathy. And I knew that there was going to be very few African Americans. There was a football player by the name of Sam Wesley, got very famous in Oregon history because he played for Canadian football for a while. He was somewhat an older student. I got to know him quite well, and a whole bunch of other students. I don't think that there were more than twenty students on campus, and most of them were on the football team. So anyway, it was an interesting experience. One of the benefits was I could get into any sporting event because they thought that I was on the team, even though I weighed a hundred and twenty-five pounds, I think, at that time.

CP: Well, what was that like for you? It must have been, obviously, very isolating, but did you—

WW: Well, it wasn't bad. I don't think I stayed in the dormitory very long. I moved into Reed Lodge sometime during that first year. And the reason I moved there was that it was a cooperative where everyone had to do work. I had some duties and we did have a house mother, which I guess is obsolete in these days in dormitories, and I remember the cost of living there was like twenty-seven dollars a month. So, just working those few hours at the hospital I was able to pay for everything, which is amazing, so my parents didn't have to contribute a lot to my education.

CP: Well, sort of on the continuing subject of the racial climate, I know there was an issue with the Greek system when you were coming on.

WW: Oh yes. Yeah, that was an interesting situation. I and some of those too, some of them were white students, didn't like the way the fraternities and sororities discriminated against African Americans. So, we organized a meeting with President Strand, who actually was only a few blocks away from where Reed Lodge is. I forgot the name of the streets in Corvallis. But anyway, he met with us, and to his credit, but then he, at the end of our discussion about it, this was kind of awkward because the school did actually have some formal arrangement with the fraternities and sororities, I don't know exactly, I don't recall what that arrangement is, but they're somehow affiliated, but separated, of course.

And he brought out the issue and he heard our arguments and so forth, but then he said he thought it was an amoral issue, and I think that kind of dumbfounded people like me. I've never used the word "amoral" in my memory, in some of the dictionaries. I had to go and look up that word. And I think it, in the context that he was using it, is it's not an issue for us to worry about. It was as if it was a separate issue or a nonfactor. But I looked upon it as a moral issue, in terms of the way the president...so, he wasn't willing to do anything about it. I suspect over the years that that's completely changed now, because all of the fraternities and sororities try to make sure that they're not purposely discriminating. They're obviously discriminating, because they have to make a choice about who comes in, but it's not based upon whether you're of a certain religion or not or skin color or that sort of thing.

CP: Was that the end of your contact with Strand?

WW: I think so. I think so. I never, well at least I don't remember any further contact with him, but to his credit, he actually met with us and we voiced our concerns. And that was—and that had to be like in 1957, '58. I think it was before I went for my master's.

[0:30:46]

CP: Let's talk a little bit about your academic progression. You started out in physics from the very beginning?

WW: Right.

CP: And I guess, tell me how that sort of evolved for you.

WW: Well, I went to—it was a bit of a struggle. I wasn't, everything wasn't easy for me, and I was very pleased that the quality of the physics staff was excellent, in my opinion. But the classes were small. As I recall, there was something like thirty-five students in the four years I was there in graduate, which meant about seven or eight students a class. I mean, every year. But they took you through the whole range of physics courses. So, at the end of the time I actually, not that I greatly excelled in any particular area, but I always had this propensity, even in my research, and at the present, I had a feeling that I needed to know everything, and I didn't overly specialize in my physics. And the same way with meteorology. I could write a textbook, virtually, on any area of atmospheric science, because I keep up on everything. I still do, I suppose. Just a habit I formed.

Because when I took my graduate, when I was working on my master's, I took—every year you had to take all your standardized tests on every aspect of physics. And I score very high in that, because I kind of knew what the key issues of science were. So, there wasn't any question that was, well I don't recall, but there wasn't any feeling that I didn't know anything about it. I knew something about everything.

CP: Was there was a professor that made any sort of a major impact—

WW: I don't remember very much about the individual professors, I really don't. But we had some crazy courses. I mean photography, which I just happened to—the photographer professor was in physics.

CP: Oh, John Garman, probably.

WW: Yeah. So, we had to take photography.

CP: That was part of the physics curriculum?

WW: It was kind of interesting, but you would think something like that wouldn't be necessarily in physics.

CP: Was it the physics of photography, or was it just taking pictures?

WW: I think it turned out to be more just taking pictures and how to do it. And you had to go through the whole process with developing the pictures and playing with different techniques and so forth and so on.

CP: Well, physicists have to be very strong in math, as well. Did that come pretty easily to you?

WW: Yeah, yeah. I took even more math. I think I ended up with enough credits to have gotten a degree in mathematics, because you had a very strong—and I think that's even true nowadays, strong applied mathematics department. In fact, when I was looking through one of my books here, because I'm writing a new book, it's interesting, several of the professors that I had are quoted in the history of mathematics books and applied mathematics. And they actually acquired one of the first computers, ALWAC, which is similar to the ENIAC. It was the army version of the ENIAC. That was the computer that I started using. I think it was 1956, '57.

CP: Can you tell me a little bit more about that?

[0:35:13]

WW: Well, it was a computer that you had to program in paper tape and machine language. It had to be very explicit, like "move A to a register and move B from the memory to a register 2" or whatever, and if you wanted to add those two numbers, you had to do the arithmetic, very arithmetic, and you had to be very literal. Then after you get the product, move it back to some other place in the memory. Everything was very explicit. And I remember that when I left there, went to Penn State, FORTRAN became available and I thought it was a godsend. It took care of all of this keeping track of stuff. You know, you can write it in some algebraic form and you don't need to worry about specific machine instructions. And it really improved the capability.

But well, I'm jumping ahead a little bit, there was—when I was at Oregon State, the reason I needed to start using the computer after taking a course or two in the mathematics department is that in my master's thesis I had a mathematical equation I had to solve, and that's when I really got into computer programming.

CP: So, even as cumbersome as it was at the time, it was clear that this was a tool that was going to be really impactful.

WW: Right. I think most of what was done in the early days, at least for people like me, is as you ended up with some pretty complicated algebraic equations, and if you look at the history of computing, some of the early pioneers were using the early computers for solving algebraic equations, where you're not going to—it would just be too tedious to try to do it by hand, or because of the repetition of everything.

CP: What was social life like for you as an undergraduate?

WW: It was good. I think I partied on Fridays and Saturdays. I was pretty good about going to the library. In fact, I tell my grandchildren who are going off to college, one of the things I tell them, I says "don't try to study in the dorm. Go to the library where it's quiet and supervised and has a place to study in the evenings." And I think most of them sort of did that, because the dormitory, there's just way too much socialization. It's hard to keep the door closed when someone's knocking on the door and wants to talk about something.

CP: Were there parties at Reed Lodge?

WW: Huh?

CP: Were there parties at Reed Lodge?

WW: Well yeah, I had friends there. And there was another building right next to Reed Lodge, I forgot what it was called, but some of the African American students were there. I had friends in both camps, in both African American and—and we did all kinds of things, but usually just hanging out on the weekend or going to the basketball game. You've heard of the famous Celtics player, Bill Russell?

CP: Oh yeah.

WW: Well, Bill Russell was going to San Francisco, I think San Francisco State or...

CP: USF, I think.

WW: Yeah, and he and Elgin Baylor would come up all the time for the NCAA games, and Bill Russell would bring his father with him. I think his father had a drinking problem, as I recall, because they would ask me and maybe another student "could you keep an eye on him?" and so we would take, make sure he got to the game and so forth and so on, but he would ultimately try to get something to drink, and at that time, Corvallis and the county was dry, so you'd have to drive out somewhere and get something to drink.

CP: That's really interesting. So, Bill Russell would come to Corvallis and you would know him, or you would—how did this happen? I mean—

[0:40:45]

WW: Well, I didn't actually have much interaction with him, they just asked me and the coaches, because I knew the coaches.

CP: So, you knew Slats Gill? Or Paul Valenti, maybe?

WW: Probably one of the assistant coaches, because I don't think I had really much discussion with, interaction with Slats Gill, although he was well-known at that time, because Oregon State had a good team and a good, it was one of the serious contenders always, for college basketball on the west coast.

CP: So, you knew the coaches, I assume, because you were good friends with the players on the team?

WW: Yeah, yeah. In fact, Prothro was a very famous coach and I was living with two football players in the early, I think, well it was my first year of my master's, so it had to be 1959, and we had this, the three of us were living in a place very close to campus. I forgot the name of the street, but we lived in a basement apartment. The rent was fifty dollars a month, so we each had to come up with fifteen dollars. And it was interesting, Prothro would, as he was trying to recruit African American students from California mostly, he'd bring them over and sit on one of our beds and bring the student in and try to have us help recruit some junior college student to come to Oregon State. It just seemed kind of strange. He never paid us or did anything like that, but I mean we were just doing a service.

CP: What was your sense of kind of their lives as student athletes?

WW: I think it was good. In fact, I think there were some students, I think, that got cars. There was some who were sort of working odd jobs that were essentially non-jobs. I never benefited from that. I don't know if you want to include this in your interview, but I think I can be honest about it; I was one of the few students that had a car and someone told me there was an old guy living up in the mountain close to Corvallis and had a cave where he was making wine. He had these big barrels of wine, like boysenberry or raspberry or apricot wine or whatever, with cheesecloth over the top, and the wine, you couldn't see through it. I mean, it was, there were bugs in it and all kinds of stuff.

Anyway, I drove up there in my 1940 Ford, and I don't know if he was really prejudiced or not, but he would always call me "nigger," I don't know why. And I would bring up jugs of wine, buy it for a dollar a gallon and take it to the campus and sell it for five dollars a gallon. I did that a number of times. I was always; I never got in trouble with the administration. I guess my sources were pretty good about not tattling about who did it. And it was a little extra income. But it was just kind of funny that this old guy just would take this bucket and put the funnel in and pour. He had a ladle and just would put some cheesecloth on top the funnel and put it in the bottle. But it was just, I could think college students never had any qualm about drinking what was marginal wine. It had alcohol in it, I suppose, but it also had probably various bugs and other things.

[0:45:49]

CP: That's great. Did you—you kept the Good Samaritan job pretty much throughout college, is that correct?

WW: Yeah, actually throughout college all the way into my master's, and first year of the master's, and then things started to change for me. I got a job in 1959, the summer of '59, at Stanford at the Stanford Research Institute as a mathematician to help with some calculations of a small group that was looking at trying to build an atmospheric model, computer model. And I thought it was fascinating. And so, that probably launched me deciding to go into the computational side of atmospheric science. And another factor was that I had this job during school time. This wasn't a summer job, working with, I can't think of his name right now. He was a professor there.

CP: Fred Decker?

WW: Fred, yeah. Fred Decker, working up on Marys Peak and having to hike up there with snowshoes in the wintertime, operating a weather radar. And I—did you see a little note in my autobiography about there was an air defense radar right next to the shed I was in?

CP: I'm not sure.

WW: And what happened was it had snowed about six feet, wet snow, and got the antenna of that big radar heavy, because the winds were blowing, and it fell over and just missed my little shed. The size of the antenna was much bigger than this room. And I called up the Air Force, said to them "you just lost your antenna," and what was astonishing is he said, I remember the words, "we'll be right up," and I said "you can't get up here, because it's snowing." And he says "oh no, we'll be coming up." I think they must have been at a fort in Monmouth or something like that?

CP: Yeah, Camp Adair maybe? Somewhere around there.

WW: Camp Adair. And there were huge plows, one shooting the snow off to the right and another and then a huge crane and a whole troop of maybe fifty or more troops and they came up and they plowed up the road and came up and lifted that antenna back onto the pedestal and fixed it. I always chuckled, because it sounded like somebody back in Washington said, you know, "we're going to be vulnerable if we don't get that antenna up," because it apparently was to identify low-flying airplanes. I think it would scan all the way up to Washington, lower part of Seattle down to California, because I think Marys Peak was just on the coast range, one of the highest peaks.

CP: Yeah, it is. It's the highest.

WW: Yeah, and our antenna was oriented towards weather, looking up storms, that's what Fred Decker had, some kind of Army contract.

CP: So, what was your job specifically with that?

WW: I just operated the radar, kept it going...

CP: How often did you have to go up there?

WW: ...and generated microfilm that we would take back to the campus. But I think it taught me hey, I don't want to be an operation meteorologist, I want to get into theory and modeling. So, it got me out of observational meteorology, the experience. I mean, it was a good experience but it really didn't have any relevance to my future career other than to tell me that this is nothing I want to do.

CP: On the subject of jobs, do I understand that you also repossessed cars?

[0:50:52]

WW: Yeah. Yeah, my brother and I, in the fifties, well let's see, no, earlier years of college. I never told my mother about this, by the way. I put it in my autobiography but she had passed when I wrote that book and she'd probably have been horrified. But it really, sort of back in those days, when you bought a car from the bank, the bank would keep an extra set of keys in case you defaulted on paying off your loan. And of course in retrospect, I never thought they should have, but I never thought about people with guns shooting you as you creep into the driveway and you're hoping that the car will start on the first turn of the ignition. So, it's not something that I would encourage any of my grandchildren to do.

CP: Alright, well—

WW: Since it's clearly too dangerous, especially in today's environment where everybody has a gun. Not everybody; many people have guns.

CP: So, you're an undergraduate at Oregon State and you're studying physics. Had you been thinking about meteorology during this time, or did that—

WW: Yeah, because I took courses from, mostly Fred Decker, where he taught sort of general meteorology. And I worked on a problem for my master's, because I didn't take those courses until I was working on my master's. But they were in the physics department. Fred was a professor in physics. At that time, physics and atmospheric science were all considered the same area, because the undergraduate program of physics really takes you through a whole litany of physics science, and atmospheric science was considered a part of that.

CP: Do you remember what it was that appealed to you?

WW: I think it was the mathematics and being able to explain phenomena, because all through physics you kind of learn that, how radiation works, how clouds work, how thermal dynamics works. So, just applying those to the subject of atmospheric science is pretty trivial. In other words, I think for someone who has studied either chemistry or physical mathematics, they can get into the field fairly easy, as long as they understand the basics.

CP: So, you completed your bachelor's degree and you went into the master's program. Did you consider any other schools, or was Oregon State—

WW: No, no. I just considered doing that. I had another complication, Chris, and that was I kept, all while I was an undergraduate, I kept getting drafted, and then I got married and we had a child on the way and that kind of kept me from getting drafted. I didn't want to go. Well at that time it was the Korean, I mean the Vietnam War, it was more the, I guess the Korean War. Wait a minute; I'm not sure when that war was over. But anyway, on the drafting, I was involved in the —at that time you had to be in the ROTC, all males.

[0:55:11]

CP: Okay.

WW: You know, as students at Oregon State, and it could either be in the Army or the Navy or Air Force. So, I think on every Tuesday we had to wear our uniforms around campus. It wasn't anything hostile about it; I just didn't want to do it. I mean, I always get like the, because I would wear my uniform, but how to take the shirt and I would just iron this part and the cuffs. Now, if they ever asked me to open up my jacket, I probably would have gotten in trouble with the sergeant or captain or whatever. But everyone had to do it at Oregon State, it was an ROTC requirement. But I just didn't, I wasn't impressed with it. And it wasn't that I was anti-patriotic, it's just that I really wanted to get into science.

CP: So, the transition to a graduate student, how was that for you? Was it pretty seamless?

WW: Pretty seamless, because most of the other students that were interested in atmospheric science didn't probably have as much of a background as I did, but having a physics background really prepared me. I didn't think the courses were—actually, my grades went up some, because I found just having the basics and then applying it to atmospheric sciences was pretty easy. And in fact, I worked on a thesis topic to understand these wave clouds that you get off of the mountains, for my master's thesis, and the only scary thing about it when I graduated, or just at the time I graduated, there was a big meeting of the American Association for the Advancement of Sciences at Eugene, and those years instead of having all the meetings in Washington D.C., there was a Pacific part of the AAAS, which met on the west coast, and then for the mountain states there was Rocky Mountain and so on and so on. All that's kind of phased into one big one now, usually somewhere on the east coast, or it can be on the west coast, but a single meeting instead of these regional meetings.

And I was put on. This was my first scientific talk at a scientific meeting and right before me, either before or after, I can't remember, was this guy by the name of Jule Charney, the most imminent atmospheric scientist in the world, was giving a talk. And I was scared, because here's the man that essentially invented computer modeling giving a talk. And mine was on a separate—it was another topic, something about the waves if it's raining, how the waves change and so forth and so on. And he didn't have anything critical to say about my talk. I was, boy, that made me feel itty gritty, because he was sitting right in the front row in the meeting at the University of Oregon. So, that gave me some confidence that I could do something. And then I applied for graduate school. I had actually applied before that meeting and ended up going to Penn State, because they had an interesting project.

CP: Was Decker your mentor?

WW: He was. He was, I didn't realize at that time that he was so conservative. I mean, had you heard that?

CP: No.

WW: Yeah, he was kind of like, I don't know if he was actually a formal member of John Byrne's society, but he was definitely a conservative about issues. And even after I left, many years, he would write me and complain about, at that

time, early concerns about climate change and global warming. And I tended to ignore him, because he kind of was—he never became a prominent denialist, but he was one of those would sign on to petitions and so forth and so on, against what the American Academy of Sciences was doing and that sort of thing.

[1:00:46]

So, I'd just kind of ignore him, although I didn't completely ignore him. If he ever wrote me a letter or called me up or had me stop in at Oregon State for one of my family visits, we would talk but I didn't really want to listen to too much of his later, in his later time. You know, Jane Lubchenco, when I was on the National Science Board, she was on there at the same time as I was; she would complain to me about Fred Decker spreading sort of nonsense about climate change. But anyway, I was stuck in-between. In some sense I felt a little stuck. I appreciated all he did for me at the same time I didn't agree with some of his conservative views.

CP: Yeah, we've interviewed Jane for this project. I want to ask you about somebody else we've interviewed, which is John Byrne. Did you have—

WW: Oh I know John, yeah. I never knew John earlier on, but one of the things I did was, which is interesting, I took an oceanography class. I forgot the guy's name, I should know him, he's very well-known in oceanography. He started the oceanography program.

CP: Wayne Burt, perhaps?

WW: Wayne, yeah. I took, it was—there again, it taught me oh, something that I didn't want to do. Because he had us go down and sit in a small boat in Coos Bay taking soundings of when the tides come in and out, and you're sitting in a small boat freezing cold all night long taking measurements, which are probably important to understanding how the freshwater from the river mixes in with the salt water. Interesting question, but getting the data was not very pleasant. Yeah, in fact I tell stories about that, sitting out there on the boat with a few of my students—I mean my fellow students—to kind of take in these measurements. It certainly made me not want to be an observational oceanographer.

CP: Well, we've arrived at the point where you're going to Penn State. I just, before we kind of head into that, I'm wondering if you could just kind of reflect a little bit on your Oregon State years and what it meant to you.

WW: Well, Oregon State was very important to me, because it was a good home, even though I mentioned some issues that we had to deal with as a minority, but I never considered all those serious enough for me to want to switch schools or not say that's a good place to go, and back over the years I've been very strong and supporting efforts to increase diversity at the institution. And I think it's trying to make strides in that direction, and I think it was a good place to go to school. I feel I got the education I wanted and needed, which paid off in terms of any successes I had later.

CP: And you've come back a few times. You've received some awards and you were a commencement speaker.

WW: Yeah. And also, this last fall, I forgot the Indian dean of the arts and sciences.

CP: Sabah Randhawa

[1:05:03]

WW: Yeah. He invited me back and they gave me a distinguished alumni award, and there was a little ceremony downtown at that restaurant, and it was very nice. I was only there for just a few hours. Well, more than hours, I slept over and I came back, because I had another trip I had to get out and get on to. Yeah, so I also, I got that award, I'm going to look up here. Yeah, a Lemon award, right there. And speaking about awards in Oregon, I got the award that Steve Jobs and Bill Gates got from Reed College.

CP: The Vollum award?

WW: Huh?

CP: Is it the Vollum award?

WW: Yeah, the Vollum award. I brag about that, because they gave me five thousand dollars as part of it. I said "I wonder what Bill Gates and Steve Jobs did with five thousand dollars." So, I found out the answer was they gave it back to the school.

CP: Oh.

WW: I kept it.

CP: Linus Pauling received that award too.

WW: Huh?

CP: Linus Pauling received that award as well.

WW: Oh he did?

CP: Yeah.

WW: Oh, okay. I didn't know that.

CP: You're in good company. Okay, well Penn State, you said there was an interesting project there.

WW: Yeah, Penn State; at that time the Air Force funded a lot of atmospheric science, especially on the modeling side, computer modeling. And there was a very famous professor there. At the time I didn't, I knew about him, but I didn't know about, you know, know a lot about him at the time. His name was Hans Panofsky. He was from a family of two Panofskys and he got his PhD at twenty-one and his brother at nineteen, I think, in astrophysics, both of them. And their father was the most well-known art historian, and he was at the University of Hamburg. And he was Jewish, so I think in 1933, just like Einstein, they left to go to the Institute for Advanced Study. So, the two sons were fairly young then and they were teenagers. And they took, since Einstein and, I think, I'm not sure, I forgot the first name, the elder Panofsky, I forgot his first name, were very good friends. But neither one of them liked to drive a car, so they took turns driving, either Einstein or both of them, around Princeton. And my thesis advisor was known as the dumb Panofsky and the smart one was known as, well he was the smart Panofsky, the younger one, because the smart one got all A's throughout their undergraduate, graduate, and my thesis advisor got one B, so they both joked about being called the smart and the dumb.

He didn't really give me a lot of direction at Penn State. There was another advisor too, Bob Duquet, but one thing that always impressed me about him, he was so bright. In the faculty meetings when they were discussing who should teach what, Panofsky always put his hand up for every course that was being offered. He was just that kind of guy. And the thing that really amazed me, being in the office or walking by or something, Hans Panofsky would be standing in the doorway dictating to his secretary a book. And he could do that. He was so organized in his mind that he could just dictate it. Not from notes, but just dictate. I guess he would, at some point, write the equations in, but he would just dictate it. I thought that was impressive. I mean, to have that sort of ability.

[1:10:37]

But he actually got his PhD in astral physics, but he picked up on meteorology and was at NYU for a while after getting his PhD. And then World War II came and they were looking for people to teach atmospheric sciences, and I think he thought he could do it and just, they hired him. And he would teach people who were being forecasters in special programs at places like NYU and other places like it. And so, Penn State was very happy to get him. He was a wonderful person to get to know and to work with. He didn't really tell—he's one of those people that didn't tell you what to do, he would just discuss an issue with you and point out several ways to maybe look at it and to think about it, which is, I think, the right way to teach a PhD-level person.

CP: So, how did you arrive at your topic?

WW: It was actually just a natural part of the project that we had, was to come up with a way to analyze data in the stratosphere and to test it out, because in those days one of the vexing problems was how do you get observations that are irregularly spaced from when they sent up these radio sons from various parts in the world, usually around some major city, or if there are key observations over the oceans or that sort of thing. How do you get that so that you can put together a dataset that you can make a forecast from? And of course the data set needs to be on a regularly-spaced grid. So, here you've got pieces of data here and there and how do you get that to a regular grid? So, it's a real kind of mathematical challenge. And how much are you missing by not having data in critical places?

And so, I came up with kind of a scheme based upon all these squares approach to, in a sense, interpolate from the irregular data to a regular grid. And then I had to test it out, so I had to generate a computer model of the stratosphere and work all—and this is something that probably a typical graduate student wouldn't do all the pieces, but I have to always—this goes back to my earlier comment about I really have to understand the whole thing, not just the pieces, to contribute to it. And it really helped me get hired at the place in NCAR. And other places were interested in me.

CP: This is where the FORTRAN came in, as well.

WW: That's right, yeah. It was all done in FORTRAN. So, I have, it was a fun project and I spent two years working on it and essentially writing my thesis in the third year. So, I only spent three years at Penn State getting my PhD. In fact, I always joke when I came to NCAR I hadn't done my PhD, because at that time Penn State only gave their PhDs in the spring graduation. Since I finished up in September, or no, actually August, I had to really wait—I mean, I never actually went to the final graduation ceremony. I was hired up here as a young scientist at nine thousand dollars a year.

[1:15:07]

CP: Well, the Penn State years coincide with kind of the national take-off on the Civil Rights movement, was that something that was impacting you during this time?

WW: I don't think so. I think I was probably more caught up in the fact that NSF, the National Science Foundation, was just getting started. It had been in existence, but when it came to atmospheric science, there was a feeling that yeah, well the National Science Foundation should fund research in this area, but at the same time they felt that there was a certain class of problems that required super computers, airplanes, large observational systems, and it doesn't make sense to put those at some, one particular university. And so, the thirteen universities that had PhD programs at that time agreed that they would send in a proposal for us, a national center, and that's what happened. I came just at the start of that.

CP: Okay.

WW: Now, what's funny, Chris, is that in those days, you know, you just kind of would talk to somebody and they would say "yes, go ahead and do that." Now in today's days, you have to write a proposal and submit over online all kinds of paperwork involved with your institution. But when I got there, the director said, "why don't you spend half your time on what you think this center ought to be doing and the other half on what you think is interesting research." That was it. I mean, it wasn't anything written down, that was just it. And then a Japanese scientist who was more senior than me, Akira Kasahara, came and he and I talked about "well, let's build a model, computer model of the climate system."

And so, he and I had lunch with the head of that part of the program at NCAR and we said "we'd like to build a computer model and make it available to universities so they can use it as a tool." He said "ah, that's what we hired you for, good idea. Get started." There was no paperwork, never was any document that we prepared about how we were going to approach it and how we're going to do it. That all came later. I just can't imagine that. When I talk to scientists nowadays and they're used to the having a plan, having it reviewed, having all kinds of paperwork if they want to start something or want to do something, whereas in those days it was just kind of "what do you need to do it? Do we need to hire a computer programmer for you?" "Yeah," or "how many do you need?" It was more like the administration was trying to facilitate you doing your work rather than you having to justify every nickel and dime.

CP: Well, it sounds like it was just a remarkable opportunity to be in this fledgling institute that had backing from all across the country and have that level of freedom given to you as a scientist, to do essentially what you want.

WW: Yeah. In fact, the elements of my new book is to talk about the early days of climate monitoring, and not only in our institution but—Dr. Kasahara and I wrote an article for, or a chapter, for a book on general circulation modeling in Cambridge. It's published by Cambridge University Press, which essentially talked about how the former groups that started the world on modeling the climate, and now it's over fifty-five groups worldwide, but so I'm trying to document in this book how did they actually get started and what was the psyche and what was the background of people that got into this field.

[1:20:36]

And especially talking a little bit about some of the physics of it. For example, in the book I'm trying to put together, I'm trying to explain why is carbon dioxide so important in this, and water vapor. Because it's not clear, unless you really dig deeply into the physics of why greenhouse gases trap heat. We say it does, but nobody talks about that, so I've had to kind of back up and go back into the literature and into quantum mechanics. And some of the work that Linus Pauling did with triatomic molecules and why they absorb infrared energy, radiational energy. So, now I'm solving Schrödinger's equation and I'm having fun with it. But it gets at the basic physics, underlying physics of climate change.

CP: Yeah. And another instance where you're having to understand the whole system.

WW: That's right, yeah.

CP: That's interesting.

WW: Yeah.

CP: Well, you arrived at NCAR in 1963 and you're still there, so we've got fifty years' worth of—more than fifty years—worth of a career to go over, and obviously we can't do that any sort of justice. What I've tried to do here is just gather some sort of touchstones or high points along the way, and maybe we can talk about some of these as we go through. But you mentioned there—

WW: Can I just mention one thing?

CP: Oh sure, yeah.

WW: It's going to be slowly coming to an end because on July 1st I'm going down to halftime for three years and then I'll be phased-out or essentially off the payroll, which is interesting to me because I'm now, in August I'll be seventy-nine, so I'll be eighty-two when I finally finish my academic career. I plan to still keep coming and going to work. That's probably I'll work a lot at home. And actually, in the old days we all had to go to seminars. Nowadays seminars are put on the web, so you watch them live or you can download them later. And so, I think it will be easier for me to keep up to date and keep involved. But my speaking tours have slacked off. In fact, I turn down things probably once or twice a week.

CP: Wow.

WW: So, I don't—I'm trying to figure out how can I help out in various ways, but I don't want to overburden myself that it affects my health or I'm trying to do too much. I'm trying to slow down. And of course Mary complains I don't say no often enough to things, but I'm looking for the right balance at this point in my life, because I know I'm getting older, but my mind seems to be as clear as it's always been. But I just don't think I can keep up with everything that people want me to do.

CP: Yeah. Well, it's good that you'll be able to get a lot done from this room that we're in right now.

WW: Yeah.

CP: And continue to be a learned voice on an issue of great important to the world.

WW: Yeah.

CP: Let's get into some of these details here. You mentioned the early years with Kasahara; my understanding is you also were part of a group that simulated Indian Asian monsoons, so that was sort of an early piece of work as well?

[1:25:10]

WW: Yeah. In fact, I think that we carried out the first simulation of the Indian monsoon, and what was remarkable about it, because up until that time there was a lot of emphasis on just doing one month and everyone thought that the most interesting month was January, because that's when the storms are strongest in mid-latitudes of the northern hemisphere. And so, we were—oh, just I need to back up just a small amount. In the early days, we didn't have coupled to the models ocean temperatures, and we, they were mostly just atmospheric models. Of course, it was always in our plans to couple to the oceans, have them interacting, but it brought up an interesting question: where do we get the ocean observations? Because the oceanographers who went out and studied oceans by sending ships back and forth and studying did it ocean-basin-by-ocean-basin. So, we had to make a global map going from North to the South Pole. And so, we would take these monthly maps of ocean temperature from various sources and put them onto a global map. And we found huge discontinuities on the boundaries between, say the northern hemisphere Atlantic and the southern hemisphere Atlantic.

And so we had to—so I called on a guy by the name of Harry van Loon, very wise, a little bit older than me, I think he's in his late eighties now, and could he help us infer what the observation—how to make the smooth map of ocean temperatures? He did and we wrote that up and published it and the other groups that were doing modeling were really pleased that they finally had a global distribution of ocean temperatures. And so, on that map, now it's spread everywhere, or not now, because now we have satellite observations of ocean temperatures, but in the sixties we didn't have that. And I think it was early seventies, I think, that we actually put that together. And then we said well, let's look at another month; July. And that's when we kind of did the simulation of the summer monsoon. I think we were the first group that actually did that. Even our first calculation, we captured the essence of the summer monsoon.

CP: You mention that when you arrived, that sort of the charge that you were given was to spend half your time on your research and the other half to help build out this idea of NCAR. Were you able to make an impact on that side?

WW: Yes, both. And turned out that the things I was interested in were consistent with the overall plan of what should be done at a national center. It didn't—even though we didn't quite always follow this. We were supposed to sort of work on problems that were too big for one department, academic department. In fact, there were some feelings that people who were not narrow specialists should probably go to the university where they could do their individual thing. And then people that would be at NCAR would be more generalists, I guess. But we didn't always follow that, because there was always sort of breakthroughs in the science, and somebody would want to have a few excellent scientists who were specialists in various areas of the science. And so, it sort of worked out fine. But the priority always was to have, sort of have things done at NCAR that probably couldn't easily be done at an academic department.

[1:30:16]

And it was a lot of back and forth. In fact, in the early days, I had to affiliate with a university, so I affiliated with the University of Michigan. So, I had to spend one quarter every three years teaching at a university. And that was part of the bargain. All of that's been pretty much sort of done away with at this point.

CP: And on a physical level you mentioned off-camera that NCAR's facility was the first structure built by I. M. Pei, a very famous architect. Do you have any memories of that particular time?

WW: Well, the thing I remember in 1964, NCAR's built on a high mesa above Boulder in a pristine environment where the city bought all of this place right in the backdrop of Boulder. Have you ever been to Boulder?

CP: No.

WW: Oh, okay. It's a—in other words, if you're in the western part of the city, you're in the mountains and all of that was owned by the city as a park. And then the eastern part of Boulder goes right directly into the plains. It really is an area where the mountain came up like this from the crushing of the continent. And in order to build it there, the city required the passing of an exception to the park, in a sense. And I think the way it was presented to the city is "the national center wants to come here and would it be okay if they built this building if it was open to the public?" And in fact, hundreds of

people come every day and use the parking lot to get a hike in to the mountain. And students and so forth. And so, it was a merging of the concept of us making an exception so we can get this national center to be in Boulder.

So, I remember in '64 going up to the groundbreaking, because there wasn't a road up to there, and they had just hired I. M. Pei, and I. M. Pei was there for the groundbreaking ceremony and he had taken a helicopter too, at the Pueblos in southwest Colorado where the cliff dwellings with the Navajo and others had built these. And he wanted, he came back with the impression "I want to build a building that doesn't compete with the mountain and sort of blends in," and that's what he did. The exterior of the building is all concrete, but brushed concrete the same color as something called the flatirons. The flatirons are some of these slabs that had been thrust up right in back of the mountain, or in the mountain. When you're in Boulder, you see the flatirons. And he made essentially the same color. And it made it look like a cliff dwelling, and that's—I think all of his art, or his architecture, he tries to spend a lot of time making things fit in. that's just part of his makeup. He doesn't just try to put an awkward-looking building in a place it doesn't fit in.

CP: And how has this space been as a place of work?

WW: Good. He came up with some interesting concepts. For example, there's a common area where the library is and the cafeteria, because he thought there should be someplace where scientists could interact. And then on the other hand, you don't want to have too much interaction, so you need—so he built towers where you would have the atmospheric chemists in one tower, the theoretical people in another tower and then at the top of the towers he kind of—look kind of like watchtowers, where you have those spiral staircases for the people who were writing books who wanted to kind of not be interacting all the time but needed some isolation from the hubbub of the other activities. And that's where people who were out writing books and wanted some isolation could do their thing. So, he had a concept in mind. I think it's worked.

CP: Well, moving into the 1970s, is my understanding correct that this is when the conversations about climate change first began?

WW: Well you know, if you go back for a century or so to the early 1900s, there were some people who were speculating about the burning of fossil fuels. Mostly Swedish scientists, and they were speculating that, well it coming clear from some observational measurements that—and this ties in with Linus Pauling—triatomic molecules like carbon dioxide, methane, well methane has four atoms in a molecule; nitrous oxide and water vapor trap infrared energy. At that time, the physic wasn't well-known, but there was a guy by the name of Tyndall, T-Y-N-D-A-L-L, a British scientist who built an observational device where he had a Bunsen burner on one end, shining a light into this tube, which he had taken all the gases out except for one or two of the gases, and then registered how much of that radiation gets through, how much is absorbed as this light goes through. And he actually pinned down this affect and he said "looks like certain molecules absorb any infrared and others don't, on their different frequency." And people didn't know why, but they knew that there were greenhouse gases.

So, this one Swedish scientist was able to speculate on what happens if we burn a lot of coal, (right at that time, coal burning was just getting started in the industrial age), and if the CO2 increases. And then there were some other observational data from Paleoclimate. In fact, the president of Penn State is my former student. He and I did some experiments in the early eighties where we tried to answer the question "how can palm trees grow at the North Pole and how can alligators grow at the North Pole?" Well, it's got to be warm. And so, we did some of the first early experiments on what happens if you increase carbon dioxide to be five or ten times what it is now. And that's during the Cretaceous Period when the dinosaurs are running around and so forth.

And so, we and a few other groups, just a couple of other groups, actually, started carrying out some of the earliest experiments way back in the seventies. And of course what was different in the earlier work is that our models got better and better and better in every generation of models so that we—the evidence of the greenhouse effect became more and more evident. So, we helped form some of the early ideas about what is likely to happen when carbon dioxide doubles, for example. And we carried out some of the earliest experiments in that. I still get citations from those early experiments way back in the seventies and eighties.

[1:40:49]

CP: In 1974, your job title at least shifted a bit; Senior Scientist, Head of Climate Section, Leader of the Global Climate Modeling Group. Was this a substantive change for you from previous work? Or just a different title?

WW: Just slightly just a different title, because what happened over the years, we hired more and more people and the group grew larger and larger. What's interesting to me is that all during that time, I became actively engaged to have my hands wet, involved in climate modeling, even the programming of the modeling. Even though we had a staff, I was deeply involved in some details that probably most people would have just sort of delegated to younger people. Well, I just kept engaged because I liked doing it. But at some point when we got up to thirty or forty people, I probably started to give up some of the administrative stuff, but I still wanted to stay involved in the nitty gritty of modeling.

CP: So, the administrative tasks didn't overwhelm your other work at all?

WW: No, no. And then in my, in the late seventies, I got contacted by President Carter's administrator, I mean science advisor, asking me to be serving on the advisory committee for oceans and atmospheres, which was the presidential advisory committee. And I agreed to do that, although it was a lot of work because we dealt with everything like fisheries to ocean science to weather satellites to all kinds of issues. And it met twice a month, so I took a lot of trips back to Washington.

CP: Well, that's an interesting part of your story, is you've had a connection to multiple presidential administrations.

WW: Yeah, some of them probably wouldn't have appointed me. For example, when Carter left office, the night before he left office, he reappointed me for another six year term. And so, I served under Ronald Reagan. Because at that time there was a feeling that these presidential advisory things should be multiagency, I mean multi-administrative, so that you give people six year terms and therefore it wouldn't be just all the advisors changing whenever the president changes, but that they stay on. But that's somewhat changing now.

Now, a complication on my first wife, or excuse me, on my second wife, came down with breast cancer and I didn't serve, I think I served two years under Reagan before I asked to be relieved of my duties because I need to help take care of my wife. But she eventually passed on. And then the same thing happened to me under Clinton. I was appointed and then just before he left office, he reappointed me another six year term to the National Science Board, and I became chair of the National Science Board for four years from 2002 to 2006. So, not only was I dealing with the issues of atmospheric science, but all of science, including social sciences, economic sciences, biological sciences. It was an interesting period of my life.

[1:45:29]

CP: Yeah. Well, I'm wondering if the environments differed substantively from administration to administration for you, in the working environment or how your advice was received.

WW: Well, I think, in the Carter to the Reagan, that was a major change because some of the skeptics of climate change were appointed by President Reagan, who didn't believe in climate change. And we had, even in those early days, some strong evidence that we had to worry about this issue. The famous Keeling Curve showing precise measurements of the trend of carbon dioxide was really the strongest evidence that we're changing the environment. And then our modeling studies worked very closely with that.

Now, it turned out that I was drawn into giving a talk to the cabinet for the first George Bush and John Sununu; you probably saw something in my book about that, right? He was Chief of Staff. He didn't believe anything about it. In fact, when I was in his office, well he misquoted me in Newsweek magazine, because I just published a paper in 1989 using a coupled model of ocean and atmospheric, one of the earliest coupled model simulations that we did a CO2 increase and then found out, of course, as you might expect, the role of the ocean, or at least one of the roles of the ocean, is it slows down the effect, just because of the heat. Some of the heat goes into the ocean rather than the atmosphere, and we all sort of knew that once we started putting the ocean with our atmosphere that it's going to slow it down. But he misinterpreted that, he said "oh, well if you have enough ocean then it's not going to show any increase for thousands of years."

And we said "no, that's not the way it'll work, because when you warm up the atmosphere, most of the warming is going to take place just in the upper part of the ocean, and so it's not going to slow it down for centuries or thousands of years.

It will slow it down in a decadal sense but not in terms of slowing it down for a thousand years. Because his argument was "well, if you go down to a thousand meters in the ocean." Well, it would take a thousand years to warm up, but that's not just how it works. The heat goes into the top and then makes it more stable and therefore you're not going to have a whole bunch of strong mixing to warm up the thousand meters down, except in a few places in the world's ocean. On my way out of his office, I was with a science adviser, Bromley, and I was asking—oh, this is kind of an anecdote. I was wondering why typewriters were operating right outside of his office in the White House and Bromley says to me "oh, the reason they use typewriters is they don't want it to be spied upon, so put things on paper and you're not putting it on the web." Makes sense, because at that time computers and workstations were already being, they didn't want to make anyone put it on the web, but you could get spied on.

[1:50:10]

But anyway, he said "well, can you give me a climate model I can run in my office?" I said "we run these things on Cray supercomputers, I don't think you can run it on your—he said "oh, I have a FORTRAN compiler on my Compaq 386. I said yeah, but you don't have enough memory to store a 3-dimensional model. And so, we went back and forth a little bit and as I left the office, Bromley said to me at the White House, "just ignore him. He's not going to—you don't need to do anything." Then about six weeks later I get a call from the White House science advisor Bromley, said "can you get him off my back? Can you get him some kind of model that he can run on his Compaq 386?" And I said "yeah well, let me think about it and I'll see what I can get back."

So, I talked to my staff and we thought we can put together a one-dimensional model, just like a one-grid point of a three-dimensional model that would allow him to do some experiments on how thick of a layer to—so I wrote a little thing about how they should use this model and not misuse it. And I didn't quite use the word "misuse," but so—oh, and actually Sununu had a PhD from MIT in electrical engineering, but it was on a fluid dynamics problem. So he knew, the first question he asked me when he called me at my house, "are you using finite differences or spectral methods or finite element methods for solving the equations?" I said, I thought to myself, "this is not the typical White House question."

CP: Yeah.

WW: "This is somebody who knows something about it." And he knew something about radiation too. He says, "are you using line-by-line calculation or a band model?" I was able to answer those questions without any problem at all, but I just thought it was shocking to hear, you know. It was like talking to fellow scientists, you know. In a sense, I was, because he has a PhD at MIT. And so, I said "well, I'll send you my book, my textbook" which was a- this is on the latest version of the book, it came out in 2007. But I found the early one. He read it. I was amazed. I mean, he was running the whole government. As Chief of Staff he had time to read my book. He kept calling me, asking me questions about this equation, or that equation.

I was astonished, and I – and the cabin officers would call me up and say, "Warren, I understand you're helping get Sununu up to date on the science of climate and climate change. Can you come and brief me? Because in the cabinet meetings we don't know what he knows and doesn't know, and so on, so on. So, I spent some time going to the ca – to the offices of the various departments and agencies; NASA, NOAA, EPA, Department of Energy, commerce. You know, I would talk to these people in private because they didn't want me to be – and then the Washington Post, the New York Times were after me, and I said, "I can't talk about nothing." I didn't talk to them about that. Because I felt – I thought that if I would have talked to the press I would have cut off giving direct information to them. Because the press would probably sort of make fun of this, and that would, I thought, would be making it harder for them to have an honest discussion about scientific issues. So, I just kept – I kept my mouth shut.

CP: Yeah. It's striking to hear you talk about this and think about the many complications that entered your life as you started to maneuver in Washington D.C., no longer just a scientist in Colorado.

WW: Yeah, yeah. Well, it was just an interesting part of my life, and I did eventually talk to the New York Times after I left office and after that administration left. I – based upon my experiences, if you want to influence policy-makers it's better to talk with them sort of one-on-one and not through the media because the media sometimes wants to say – was asking stupid questions or – and so forth. A good example is when I was asked to brief Margaret Thatcher. The press wanted to come to that event, and what Margaret Thatcher wanted, and she told us this through her science advisor, was to

find out what the latest was on the science. And she didn't want the press there looking for some stupid question that you might ask.

And so, I put together a small team of scientists to work with me in case I couldn't handle the question, because she was an organic chemist. She went to Cam – Oxford I think. And so, she had – she knew something about the science of climate change, but she wanted to ask any question without feeling that somebody's going to be talked about in the press as being a stupid question to ask and why'd you do that, you know. And I also had the good relationship with Al Gore. Al Gore wrote a real nice letter for me on my – on that TV show, An Evening with Warren Washington. Yeah. But seeing him privately with a few other scientists was, I felt, the right way to do it, so he could ask questions and not feel he was being hounded by the press. I work with the press too. I mean, not that I don't work with the press, I do, but I just feel that when you're talking to policy-makers that you ought to respect them as part of their learning process and not be made fun of.

CP: I want to ask you about your textbook. You referenced it. So, this was *An Introduction to Three Dimensional Modeling*, written with Claire Parkinson, first published in '84 and a second edition published in 2005. I'm interested in kind of the process of writing the book and then the impact that it's made.

WW: Well, it's – I think it's had good impact. I think the process was basically – Claire was my former student. She's a good friend, and she works at NASA running one of the satellite programs. And she's a very good mathematician. So, what I essentially tried to do there was to start with Newton's laws, ethic laws, and then go piece-by-piece through how you get the equations in motion. And it's deeply mathematical, but on the other hand, we tried to explain each step, because when you read a scientific article in our field, and as probably all of the fields, the assumption's always made; where did that equation come from? "Well, so-and-so did it; you can read all of the previous articles and figure out how it gets from Newton to this form of equations." Well, we put it all in there, just step by step.

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And so, I think the students like it, because they don't have to guess how that equation was put together. They can actually get a—now what I'm doing in the present book is going back even a little bit further and to...on things like radiation. I'm trying to answer the question why certain molecules absorb radiation and others don't. So, it has the same sort of flavor but it's going to be concentrating on the early modeling, a little bit of history.

I'm going to a workshop in mid-June and three-hundred and fifty scientists will be there. Most of them are specialists in every part of the climate system you can think of. But maybe this is my going back to the broader issues, sometimes. I mentioned earlier, most of them have no idea what's in the rest of the model, other than their narrow, focused area. And so, books like this, I think help them get a broader view of how you, first of all, get the equations and how you solve them on supercomputers. So, I'm still giving lots of talks in these areas.

CP: Yeah. I'll ask you about a couple of professional affiliations as well: president and cofounder of the Black Environmental Science Trust?

WW: Oh, this was a scheme of my own, which didn't work out. We went to—there's a lady I was working with—went to a foundation here in Denver, one of the local foundations, and argued to them that we don't have enough African Americans engaged in this field and could they give us a small grant? I think they gave us like ten thousand dollars. And so, then I used that money to work with some people that really had big money, to look up this idea. It think most people felt yeah, we have historically black colleges, like my father went to one, and they typically teach things like physics, chemistry, biology, but that's usually it. They don't teach geology or atmospheric sciences or oceanography or things like that. And so, we were hoping that we can find some other program that would allow them to have some students in somewhat different areas use their physics or chemistry or whatever it is, biology, in the area of atmospheric science so they can get educated and be in the next generation.

And we got some support to keep this foundation kind of going, but never really enough to get it going. And now, I think it's been superseded by just a general interest in diversity by the American and the scientific societies. Now when I go into the American meteorological society annual meeting, which I was president of twenty years ago, we have one evening for students with different diversity getting together and for faculty meeting with them. And now I walk in and instead

of just being the second African American to get a PhD in the field, there's a hundred students there now. And if I go to the American Geophysical Union meeting that's in San Francisco, they all—and I helped them come up with the idea of having some special focus on diversity issues. And now you see hundreds of students with different backgrounds coming together.

[2:05:11]

CP: That must be very gratifying.

WW: Yeah, it's very satisfying. So, I think the need is still there to a certain extent. And if you talk to any dean in the sciences, at Oregon State or anyplace else in the country, even though they have to be careful with their Supreme Court ruling that they can't give preference, they do want to do diversity in various ways. And we have a program at NCAR, which we've had for over maybe twenty-five or thirty years, where we bring students in from Puerto Rico, African American, underrepresented groups, and they go and they get NSF funding all the way through undergraduate through their PhD. And they spend summers at NCAR but they go off to their respective universities, and that's a very successful program. It's generated numbers of undergrads among minorities. And I was involved in that.

I used to—this is how I went to Talladega for my father's, I would traipse around these historically black colleges giving talks. And I was happy to do it, but usually would be like I'd get a letter or email a little bit later that says "I'm interested in going into atmospheric sciences" and I would kind of hook them up with somebody at a certain university. I would ask them some questions, kind of "where do you want to go to school" and "how do you want to specialize then?" and so forth, so on, then I would contact that school to kind of see if they can work out something. And in most cases, they do.

CP: Well, as we start to wind-up here a little bit, there's a couple big events we definitely need to talk about. The first was in 2007 with the Nobel Peace Prize awarded to Intergovernmental Panel on Climate Change. They used a lot of NCAR's work and I'm interested in kind of your experience of that.

WW: Well at that time, I was engaged in it and writing papers with my colleagues, and there was a small group of modeling groups, maybe at that time, maybe five or six or seven who were doing experiments. And so, we kind of agreed about in order to get away from the differences in our models, we sort of agreed that all of us would do some standard experiments, like a doubling of CO2 or a gradual increase of CO2 in a certain way and then write up a paper involving all those groups, to come up with a consensus. And that's what the IPCC eventually got into.

And the reason that we wanted to sort of do that was that it was a little bit confusing to some people why one model would warm up more or less than another model. And we can look at model differences. And the overall trend, of course; as you increased greenhouse gases, a warming trend. There's no cooling trend, but we'd all use the same set of forcing [?], and therefore we could talk about the uncertainty as being model differences. And I think that was an attractive idea for getting accepted by the community and a consensus, because ultimately what the IPCC does is give advice to the policymakers. And that's a two-step process. One is to—or three-step, first do the experiments, secondly analyze model differences, and then the third step is to write it in a way that policymakers can understand.

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And we always call that the summary for the policymakers, which is the end product. And it had to be written in somewhat of a scientific way, but you didn't put in all the references and all the details. All of those were left in earlier documents. So, there were three sets of documents. And I think it's been wildly successful. It hasn't convinced certain people, mostly people from the oil and gas industry and others that have axes to grind, that this isn't a problem. But we understand a lot more than when we started out. I mean, we're able to look at the past climates going back to a million years ago.

It's not just based on modeling calculations but looking at how high is the CO2 concentration likely to be at the time of the dinosaurs, or we can, there's ways to infer that and to understand it better from bringing in the geological information. And we can make good predictions, I think, of what happens in the future based on what scenario the world takes on cutting back on emissions. We certainly know what happens if they don't do anything, but the question is often do we, I mean how much do we know if we cut back by fifty percent or something like that?

I applaud Obama, who I interacted with, because he knows he can't get the countries of the world to agree in the normal UN style, so he's going around getting each individual big user, like China, India, so forth, to agree on cutting back emissions. It's a good start, but as someone who has sixteen grandchildren, I'm worried a bit about what this planet's going to be if we really don't do something about this problem.

CP: What was the scene like at NCAR when the announcement was made of the Nobel Peace Prize?

WW: Very excited. Now, what's interesting, I don't really brag about the fact that I have some small part in that, because I think—and the reason is, typically the Nobel Peace Prize is given to individuals for breakthroughs or doing something in science, type of thing. So, this is a new kind of, sort of a thing. On the other hand, a lot of the modern science, and you see this, I think, in your history of science; a lot of the issues in modern science are really done by groups of people. And this is one example: if you think about satellite technology, which has been mushroomed hugely in the science, in the geosciences, it's hard to put it on one individual doing some single breakthrough sort of thing.

Now, Linus Pauling in his day, he was able to kind of, with his book on the chemical bond, he was able to kind of really invent something at the discovery level, of how things worked, and did a brilliant job. But if you look at the biological sciences now, you're seeing teams of scientists working on DNA and gene sequencing and so forth and so on. It's not like there's this one person making a breakthrough; its groups that are making breakthroughs. But there will still be opportunities for individuals to make great—I'm not saying, it's just the style is somewhat different. When I think about quantum mechanics now and this big accelerator they have in Switzerland, it's a big operation to kind of get all of these physicists to try and figure out elementary particles. And it's not just one person that's doing it; it's five hundred people are making their contribution in various ways. So, just an issue.

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And I think on this issue of climate change, we still require large groups of scientists to be engaged, whereas the group that we started with when we built our first model of only four or five people; a couple programmers and Dr. Kasahara and myself at NCAR.

CP: 2010, the National Medal of Science, I'm interested in how you learned about it and then the whole experience of receiving it.

WW: Well, two things about that was before I became, I got that medal, a young senator contacted me through his secretary, if I would be on a panel with him. And that was Barak Obama. This was 2007. I never thought that he was going to be actually running for president, but he invited me to a conference at the Congressional Black Caucus, which is a big event for African Americans. It's kind of a think-tank thing that they have every September to push for their issues of concern to African Americans. And it was a workshop on—not a workshop, but a session on climate change. And most of the people who are going to this thing are people in politics. So, I agreed to come and speak for a few minutes. And he invited, I think, four other speakers, including the fellow who wrote this book on Percy Julian, who was also at that symposium on Linus Pauling at Oregon State. I'm trying to think of his name, but he was also on the panel.

So, we all gave our little—oh yeah, and that was another thing, I thought it would be a couple hundred people at the convention center. It turned out to be a huge room, like five thousand people were there. And so, I gave my talk and everyone gave a little ten minute talk about what they did and what their concerns about climate change were. And then Obama came out and it was as if he had just read the latest IPCC report—it's one of the earlier reports—and he didn't have any notes. I was, I think, two down from him, from the front, and so I got a chance with him a little bit after this whole session was over. And my wife Mary, who was there, actually stood on two folding chairs taking a picture of me with him. He was more at my back, but that's my first chat with him.

So, then I didn't hear much during his first year. Well, sometime in the first year. Then I got an interesting call from a lady at the White House. She wanted some more information about me and she said that "you're being considered for a Medal of Science Award." And so, I eventually was announced. Now, what was interesting about that, she says "well, you can only bring three people to the White House and in the East Room." I said "gee, that's a real problem for me. I have all these children." Because if I count my children plus my, you know, the wife who had passed away and my present wife's

children, it came to seven children. And she said "oh," she said "I'll keep that in mind then if we get any cancellations from any of the other ones, I'll sneak them in," or put them on the list, because you have to get them authorized before.

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So, it was a really nice ceremony and everything. In fact, they asked me before the actual formal ceremony if I would go to the Executive Office Building, which is right next door. In fact Stanton, I think General Stanton, he was secretary of, I think it was—oh, secretary of war, that's what they used to call it under Lincoln, in his office, if I would take a call with children, school children across the country. I don't know how they sorted out what schools and got a kid to ask questions. But he said "there's going to be another guy with you and he's going to be joining you" and I said "who's that?" and he gave the name. I forgot his name actually; right now I've forgotten it, but he was the inventor of the digital camera. He worked for Kodak in the early days when pixels were huge. You could barely make out a figure. He went through the process.

But he was a really interesting guy, but I was proud to be with him. And we just sat there for a couple of hours taking one question after another; weather, climate, global warming on my side and he took them on how do digital cameras work and so forth and so on. We had fun with it. We had a really good moderator. Then at the ceremony, it was very nice and we actually were in the East Room. And I have pictures of it all and even video of the ceremony and all that stuff. And then after the ceremony we went into the Blue Room, which is right next door, and each one of us got like fifteen minutes with him, with the president. And of course my first question was "do you remember me?" and he did. Yeah, so I had a nice conversation with him.

I haven't, I never had a formal presidential appointment with him, but I've helped the administration out. The major way I do it is that I, I think I mentioned earlier in your questions, I chair the academies' committee that advises on the global change issues. And that goes all the way from basic research to applied policy. And it involves thirteen agencies and departments, has a budget of 2.7 billion. So, the president of the academies, all three presidents appointed me for another three years to serve on the committee as chair. And I know the chair and the president of all of the academies; health, engineering, and science.

CP: Well, the last thing I was going to ask you we sort of touched on already. It was kind of your sense of the future of the warming world. I'm wondering, you mentioned you're worried, I'm wondering if you're seeing things that are making you hopeful at all, particularly within the scientific community.

[2:25:07]

WW: I think I'm seeing things. You know, if you look at the polls, most people now are aware of climate change. I think I'd say that seventy percent or seventy-eight percent feel that we should do something about it. So, I think there's some exaggeration of the uncertainties. There's some people that have written these books by comparing the smoking, on whether it causes cancer or not, and it's the same group of people who were involved in trying to discount that as are trying to discount global warming, in spite of overwhelming scientific evidence that this is a serious problem.

So, I think a major part of that skepticism comes from news organizations like Fox who really, you know, Rush Limbaugh and people like that have, at least in my opinion, abused freedom of speech when they just out-and-out try to misinform people. And yet, the American public is aware now that something is changing in the climate system, and you're seeing all kinds of proof of that in Oregon and even involved in the fisheries area and the drought areas and so forth. And I don't know how we're going to overcome that. It's worrisome to me that we're ignoring scientific, at least a fact, in my opinion. And even if there's no fact about it, have you ever heard of something called the tragedy of the commons?

CP: Mhmm.

WW: Do you know where that came from? I talk about that a little bit in my book.

CP: I don't know.

WW: The tragedy of the commons, have you ever been to Boston?

CP: No.

WW: Okay. When you go to Boston, in the downtown area right next to the state capital building and where there's a common area, it's a—I think you can really think of it as the first American park. And everyone around there had cows and horses and so forth and they would graze them on the common and this guy who was a scientist at Harvard, his name was Garrett ...yeah, I forgot his last name, actually wrote a book on the tragedy of the commons. When it gets to a point where you add another horse or cow, it's not sustainable and the grass sort of disappears. And there's a threshold and he talked about that, the tragedy of the commons and how it turned from pasture land to where it wasn't sustainable. So, in order to solve the problem, the people who lived around the park had to kind of come to some agreement about how many horses or cows that they would put out.

And the goal was sustainability, and that's what is the ethics of dealing with this problem with climate change, is that we need to kind of get the countries of the world to agree, instead of just pointing fingers, you know; people in China saying "well you guys caused this problem starting back in 1850 in Europe and the U.S. and we were underdeveloped and we weren't putting much CO2 in the atmosphere. Now it's our turn to put stuff in the atmosphere." We're both—you're not going to solve it by saying "okay, U.S. and Europe shut down their industry and solve that," you know, stop driving cars and all that.

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So, I think this tragedy of the commons is a way to kind of explain that there's a limited carrying capacity and the broader sense of global warming is that we all need to share and not go to the same path as we historically have done it. We've got to all cut back. And the people that are the largest users, that's why Obama's running around at these various national meetings trying to get the bigger users to cut back first and get them to commit to cutting back.

Now in a practical sense, I think people in Florida have learned the hurricanes are going to get worse and worse, and it used to be that if you lived in Florida, you could buy house insurance to deal with it. Well, all of those companies have left Florida that insure—and then the state tried to do it. Now, if you want to get house insurance that would protect you against hurricanes, the average price is eight thousand dollars a year. More than the mortgage at many houses. So, I think economically, see the insurance agency, as I always watch the insurance industry because they know, based upon statistics, how much premiums they're going to charge versus how much damages they're going to cover. And if it's out of balance, they have to adjust. And the insurance industry is going to probably, I think, have a big impact on the flooding that you see in Florida and in Texas.

Well, most people didn't buy that flood insurance from the government, but every year now flood insurance is going to go up because they're going to get more claims. At some point people are going to say "god, I can't afford to have flood insurance" and then "isn't the government going to help me out?" Well, I think what you need to do is tell people "don't build your house here. Go build it on that hill over there and you won't have to worry about the occasional flood and then expect the taxpayer to pay for it." So, I think that things are going to happen based upon what we already know.

There's something called the National Climate Assessment, if you've heard about this? I chaired the committee to review a thousand page document—eleven hundred page document, which really gets down to telling people what they need to know for city planning, for how to deal with climate change in agriculture and urban areas, rural areas, and so people have now, in the U.S., because it's a national climate assessment, a place where they can go to get information. And thousands of people are using it at any time. It's online, so you don't—because they figured in order to update new information, new science comes in, that they can update it as to give information back to the citizens and the policymakers in rural areas as well as urban areas; what they need to know to deal with this issue of climate change. And very practical stuff.

And I, if you ignore it, you're doing it at your own risk. And flood insurance used to be completely subsidized by the...not completely, you would pay two hundred dollars a year. Now, Congress changed it a couple years ago so that it was brought into line with the realities of what the real risk is, and now it's several thousand dollars and it's probably going to go higher, because to cover disasters like in Florida, out of Florida from hurricanes or Texas and Oklahoma, people shouldn't be building in places where it's going to flood. Even if the probability in any one year is pretty small, but over ten or fifteen or twenty years is not that small, and if you have to replace a house or some other structure or some, or have loss of life, including the infrastructure, bridges and roads and all that.

[2:35:48]

So, I see a change in attitude and acceptance, but you wouldn't believe that by reading the press. But the people who carry out polls and polling; I see it happening and it's been getting more and more disastrous. For example, with flooding we know that when you increase the ocean temperatures, you put more water vapor in the atmosphere and that as the energy that goes into driving storms, whether in the form of hurricanes or tornados, but also in terms of heavy rainfall events, we're seeing it just moving things up to being more and more intense. And even droughts. Are we still in a drought over western Oregon, in the southern part?

CP: Southern part definitely, eastern Oregon somewhat.

WW: Yeah. Well, we're going into an El Niño year, so I think for us we're expecting that the rainfall will return.

CP: It will be welcome news to many.

WW: Yeah. Especially for the people in California. The El Niño is here, no question about that, but it hasn't changed the overall patterns yet. It's likely to have its biggest effect in the winter season when we get a lot of storms coming in from the Pacific.

CP: Well Dr. Washington, this has been fascinating, I really appreciate the generosity that you've shown today with your time and your perspective and your memories, and I wish you all the best for many more years of good work.

[2:37:49]