Molly Graham: This begins an oral history with Tom Karl for the NOAA 50th Oral History Project on April 25, 2022. The interviewer is Molly Graham. It's a remote interview with Tom in Mills River, North Carolina. I'm in Scarborough, Maine. Last time, we had gotten up to the point where you had spent some time in North Carolina and then moved out to Alaska for some jobs. I'm wondering if you could walk me through that time in Alaska, and then bring me back to Asheville.

Tom Karl: Sure. I spent a year at that Weather Service Forecast Office in Anchorage. Really, I loved living in Anchorage. It was really a learning experience. The Weather Service forecast office up there was pretty unique in terms of its responsibilities from forecasting for marine interests out in the Pacific Ocean. Literally, these fishermen are taking their lives in your hands. So, it was pretty serious work. Obviously, Anchorage at that time was a major airport for transcontinental flights. So, a lot of flights landed in Anchorage. You had a fair bit of air traffic in that area as well. To get around Alaska, bush pilots were key; they would go through passes, and forecasting for what the weather was in those passes was extremely important to them. So, of course, then there was public weather. People are interested in weather from the public perspective. So, I learned a lot up there. I always wanted to be a weather forecaster. A lot of people up there have considerable experience. The weather in Alaska – everyone says where they live the weather is unique, but it was really unique up there. It was very, very difficult to predict from the standpoint if you had coastal issues with the ocean up against major mountain chains on the land. So, it was quite a challenge. In fact, I can remember, back in those days, the models weren't quite as good as they are today by a longshot. They were just coming into their own. I can remember being on some of those forecast desks. And we'd look at each other and get a report that it was snowing in some pass and scratching our heads, "Well, why is it snowing there? We can't figure it out." So, we've come a long way from there. It was a great experience. While I was there, part of the difficulty was we were always short-staffed, and I was very interested in doing research. Being short staffed meant you'd be called in all hours of the day. While I was there, I had an opportunity to apply to the Air Route Traffic Command Center. I applied there, got that job, but before I even did that, I also applied to the National Climate Center [NCC], at that time that it what it was called, located in Asheville, North Carolina. I had been through Asheville because I worked in Research Triangle Park [RTP], and my parents lived in Chicago. So, if you drive from RTP, Raleigh-Durham, you go through Asheville all the time. And I'd been to Asheville for meetings once or twice while I was in Research Triangle Park because obviously Asheville had all the data, all the weather and climate data, and we had some relationships with the people there in terms of developing models for air quality. So, I was familiar with Asheville, but I never felt I would actually live there. I applied for the job, a job that was advertised. They were interested in someone who could work on a new model that the Navy had just developed, the Spectral Ocean Wave Model. That was something I had not been experienced with, but because I had written some papers and research papers, they felt like I could help them analyze the data from that model. It's producing tremendous amounts of new data. They did what's called a retrospective historical look. That is, you fed into this model sea level pressures, wind speeds historically, and then you ran the model to produce ocean waves, and they could resolve these ocean waves into a spectrum. So, you knew the energy in these waves at various frequencies. This was extremely important for the Navy. The Navy was actually funding this work to be analyzed at the National Climate Center. They were interested in it because they had critical operations in all the oceans, and this model was able to produce

some important data. Well, as it turned out, there was interest beyond the Navy and the data; there was an oil consortium that was developed, and they were very much interested in looking at the data because they were transporting oil across the oceans in these new major ocean-going vessels that were of tremendous size. They wanted to make sure these things weren't going to sink with the waves. So, it was a great opportunity for me and the center to look at this data. I learned a lot; I think the center learned a lot because we always had ocean data from observations from the ships, which would give you wave height and wave frequency, but they were scattered, and they would go along ship routes. What this model offered us [was] the opportunity to look at data across all the oceans outside of the ship route, and you could then determine whether or not there may be more effective routing that would be a possible approach. So, I worked on that for the first couple of years back at the National Climatic Data Center, but that didn't take up all of my time. I worked in the Applied Climatology branch. I had a great supervisor, Rob Quayle who said, "We've got lots of data here that really people haven't looked at. And one of the problems with our users is that if they look at the data and no one has looked at it, there could be a considerable amount of problems that they could run into and they don't know how to deal with." Because, at that time, the National Climatic Data Center was sending out tremendous amounts of data for people to analyze. There's a fair number of complaints that they didn't know when to believe it, when not to believe it. If you get some errant data and if it's really off limits and you're running, at that time, computer programs, it can really throw your programs off and really throw off your analysis. So, it's important to take a look at that data. We did that with a number of colleagues both at the Climate Center and across the university community. Some of the things that we really focused on – this is in the '80s now – was drought. There was a drought index that was developed by Wayne Palmer and the Weather Bureau called the Palmer Drought Severity Index, and that had been extremely popular for agricultural purposes, hydrological purposes, but it wasn't run regularly, and it was a fairly complex model; people really didn't understand it. We did some analyses, really diving deep into that model. Wayne Palmer had retired. We took a close look at it [and] published a number of papers on what its sensitivities were, how best to use it, and it became extremely popular. I mentioned it now because later on, back in the 21st Century, that dataset became extremely important in the National [Integrated] Drought Information System called NIDIS, which is an extremely useful information system that provides information about the state of drought conditions across the entire United States. It obviously can run in other countries, but in particular NIDIS looks primarily at what's going on in the US. Without that work in the early '80s, it's doubtful NIDIS would have been as successful as it has been today. So, there's important foundations. We looked at drought, but we also looked at the variability of climate. At that time, if people look back – and you have to be old enough to remember, but in the late '70s, we had three back-to-back extremely cold winters. Then they were followed by some very warm years. Lots of climate variability. People were scratching their heads, "Well, what's going on here?" So, we had all the data at NCC. We took a look at it, tried to analyze it with the help of colleagues, outside of NCC in NOAA [National Oceanic and Atmospheric Administration] and outside of NOAA. Are we seeing changes in climate variability? We looked at temperatures and precipitation. We published a number of articles looking at climate variability in the '80s and previous to that. We found some pretty unusual things happening. At that time, there weren't trends that we noticed, but the odds of some of these unusual events happening were extremely rare. And rare things do occur, so people didn't walk away with, "the climate is becoming more extreme," but they did walk away with, "we've had some unusual conditions."

At that time, there were a number of workshops. Jerome Namias, who used to be part of the Weather Bureau Long Range Forecast Group in the ’50s, and he left and went to the university in the ’60s. But he called together a number of scientists to try and understand what was going on. One of the advantages of him doing that is it really highlighted the importance of the data at NCC, which in the early ’80s, became the National Climate Data Center [NCDC]; they changed their name. So that was really an important point because we had a lot of scientists and users outside of the scientific community really advocating for better looks at the data, making the data more accessible. Previous to this time in the late ’70s and early ’80s, you got your data – it was paper records. Microfiche was very important. Computers were just really coming into their own with magnetic tape. Prior to that, punch paper cards. So, where I worked at NCC, which then became NCDC, we had so much data that the engineers who looked at the building that we housed all the data in, in Asheville, said because of all the weight of all the punch paper cards on the floors in this building, there was structural damage to the building. [laughter] So this was just another reason to move that data from punch paper tape and manuscript records to, at that time, to magnetic tape. So, there were huge programs to take that data from these punch paper cards to magnetic tape. I wish I had some pictures to show you. But if you can imagine, five floors – and many of the floors are just columns and columns in the hallways, in the rooms, of trays of punch paper cards. It was really a sight to see. Eventually, we were able to migrate all that data to magnetic tape [and] later, hard disk. A lot of that magnetic tape went to hard disk. But tapes are still important today because there's so much data in terms of petabytes. Nonetheless, that was a major undertaking. Danny Mitchell, who was the director of the National Climate Center, which then became NCDC, had headed that project and was extremely successful moving that data to magnetic tape. Without doing that, it would have been impossible to analyze all the data that we did at the center and the users got access to. Why this data is so important is that there are so many sectors of our economy that are critically dependent on weather and climate conditions. This includes – obviously, agriculture comes to everybody's mind, but even things like if you are going to the store to purchase items like outdoor furniture, buying coats, seasonal apparel; it's extremely important that shippers ship at the right time. So, they're very dependent on looking at the historical data, understanding when they can ship, when it makes sense, what's the probability of heatwaves, cold waves, when you get freezes, if they're going to ship plants and you're going to plant. It's very dependent on knowing when is it likely we're safe and when we're not going to be safe. But in addition, there's other sectors like insurance. Insurance is extremely dependent on how much hail, tornadoes, hurricanes, floods. If you're going to be in the energy industry, you have to know whether or not your cooling demands or heating demands are going to be met by the size of systems you're going to put in. So, there's a whole area of heating and cooling degree days, [which] a terminology that scientists use to try and calculate how much heat or cooling would be needed during the course of the season. We used to say there is no part of the economy that's not affected by the weather and climate data. No bridge is built, no road is crossed, transportation – structural engineers all rely on this weather and climate data. So, we worked with ASHRAE, which is American Society of Heating, Refrigeration [and Air-Conditioning Engineers], to provide them with the kind of data and information they needed to design the standards that then were put into place if you're going to be developing commercial buildings or residential buildings. It's really quite amazing just the amount of interactions that we had. We had a whole group of people, about twenty, twenty-five people in the branch, which was called the user branch. All they did – well, I wouldn’t say all they did – but one of primary things they did in the early days was answer the phone from users

ordering and asking questions about the data and information we had. As the internet obviously came into vogue, it was email back in the early part of the 21st Century. That was really important for them to address. But back in those days, it was telephone calls and talking on the phone and letters. People actually sent letters in, believe it or not responded by letter mail through the post office. So, the '80s was a great time for really developing a great foundation for some of the important work that took place in the '90s and later on. So, in the '80, for me, I was fortunate because I was able to do all the research and interact with colleagues and scientists in the US, both in the government and outside the government, to help look at this data and provide them better access to it.

MG: Can you remind me when NCC became NCDC just so I have that?

TK: Yes. I believe it was 1982. I believe that was the time. It was an interesting history of trying to figure out where NCC belonged within NOAA. It started out in the Environmental Data Information Service, which made sense because that's what we did [was to] provide a lot of information. Eventually, it ended up – by the time I got to NCC, it was in the National Environmental Satellite Data and Information Service [NESDIS]. So, we were put in with the satellites, which obviously was a much bigger organization. It takes a lot of resources to put up satellites, but they were putting out a lot of data, so it made sense from that standpoint. Interestingly enough, as a backstory, some people may wonder why NCC is located in Asheville. Well, the Weather Bureau recognized in the '50s, after World War II that it was important not to throw away the data that they were collecting. Not only data that we were collecting in the US but exchanged internationally. If you're going to predict the weather, you have to know what the conditions are not just here in the US but across the rest of the world. So, the World Meteorological Organization [WMO] was developed after the war; facilitating the exchange of data was a critical part of what they did. NCC was a critical part of WMO in terms of helping to forge agreements for data exchanges, developing things like world data records. But what was a key component of developing NCC in Asheville was, at that time, that there's all these paper copies of data, and you need a large place to store it. At that time, there were a number of regional collection centers – San Francisco, New Orleans, Washington, DC. Asheville happened to be one. Eventually, the decision was made. We could probably be more efficient if we put it all in one place. Asheville just happened to have the biggest basement of all the different locations. So, it ended up in Asheville, North Carolina, to be the national center. It's an interesting backstory because normally, if you pass through Asheville, it was known for being a very pristine location, the Smoky Mountains, next to the national park; furniture making at that time was really important. Scientific analysis was not something you put together with Asheville and NCC, but that's where we ended up.

MG: Has the scientific community there developed more since?

TK: So interestingly enough, I can get ahead of the story. One of the problems with developing a high-tech science center is having a major university nearby. We do have major universities a few hours driving distance e.g., Clemson in South Carolina. We also have a component of a major university, UNC Asheville. It's gotten to be today an extremely excellent – an excellent humanities school. It is probably now about seven or eight thousand students. At that time, it wasn't quite that big. But it's not quite the same as having an R1 university, like NC State in

North Carolina or University of North Carolina in Chapel Hill. It's quite different in terms of the amount of research that goes on at those locations – or a Duke compared to what goes on at UNC Asheville. Nonetheless, we tried to work with UNC Asheville because they did have a Meteorology Department. I actually took a few classes at UNC when I was here. I wanted some additional learning in programming and hydrology, which were very enjoyable. I later went on, in the '80s, to teach a class over there, a basic statistics class for a year or so just to see how that would be. What we did is try to encourage UNC-Asheville to play to their strengths, which was to help us with the social aspects. What are the impacts of these data that we have socio-economically ? They eventually formed a program to do that. In addition, in the early 21st Century, we recognized we probably needed a little more. So, we worked very hard to get a co-op institute. NOAA has these things called cooperative institutes, and the cooperative institutes are extremely important because they've worked very closely with NOAA to try and use NOAA's models [and] data, and use that in terms of state-of-the- art analyses and research. We were fortunate enough to get North Carolina State University to put together a co-op institute, co-located with us in Asheville, and they're very active today. That was an important aspect of trying to get more research from major universities engaged in what NCDC has.

MG: How do you institute those kinds of changes? Tell me about the strategic planning involved and one makes those really fundamental organizational changes?

TK: Yes. You have to have patience, because there's a whole suite of processes that NOAA has in place for a good reason to try and accommodate needs, but do it in a way that's consistent with the way the agency has operated. It took a couple of years for us to convince the leadership in NOAA and the leadership at the various universities that there was a golden opportunity here. So, we put out a call for proposals, people proposed what they might do, and eventually, we got the resources from NOAA to fund the cooperative institute to do this analysis work. I'd say it probably took a couple of years to get that moving, but it was well worth the investment.

MG: I was also curious who was hired to do this migration and the ingestion of all the data that was maybe a little unorganized or on more obsolete media.

TK: The movement of data from punch cards – well, first, from manuscripts to punch cards to microfiche, to magnetic tapes to hard disks. That was really pushed, I would say, very strongly by our NESDIS leadership. I mentioned Dr. Mitchell. But also who was key was Greg Withee. Greg had the Ocean Data Center. We had three data centers – one was the ocean, one was geophysical, and one's climate. And he managed the Ocean Data Center prior to him being the director for NESDIS. Because of that background, he was always pushing for the treasure trove of data to be made more readily available and was always advocating to senior NOAA leadership, to new administrators, how important that would be. That was a key component of this whole process. Once this process got moving, once you had the data on magnetic tape or hard disk, where it was more accessible, you can imagine people were clamoring [to] make it accessible in a way my computer programs can read these different datasets more readily. So, you can imagine; you have one data set in one format for oceans, one data set and another format for atmospheric data, another dataset for surface data. You have all these different formats, and you had a number of users who said, "Well, we don't just want one dataset; we want multiple datasets. We don't want to have to rewrite computer programs multiple times every time we

want to read one of these datasets." So, there was a great need to try and develop ways in which one could homogenize the access to the datasets. There were a number of programs aimed at improving data access. How this evolved – in the late 1980s, there was a call for putting together all this different information into understanding the global climate, what's going on globally. There was a recognition it couldn't be from any one center, any one agency, not even any one country, but the US said, "We think we can do better than what we are doing today." There were a number of leaders in various agencies in the government – Department of Energy [DOE], National Science Foundation [NSF], NASA, and NOAA. These leaders sat down for breakfast. My understanding was, I was not part of their breakfast meetings, they did this for about a year or so. At the same time, they were talking to members of Congress about how we could do a little better with the data and information, we had to look at the global climate situation. At that time, Congress had the foresight to produce what they called the US Global Change Research Program [USGCRP]. They produced an act, the US Global Change Research Act. It was passed in Congress under the first George Bush in the late '80s. Key agencies at that time were DOE, NOAA, NSF and NASA. The key leaders of each of those agencies historically who had this discussion – Ari Patrinos from DOE, Bob Corell from NSF, Mike Hall from NOAA and Shelby Tilford from NASA. Who else? I think that was it. They had the wherewithal to produce programs within each of these agencies that would execute any funds that Congress provided. The act itself named a number of agencies beyond those key agencies that I mentioned – USDA [United States Department of Agriculture], EPA [Environmental Protection Agency], Health and Human Services. DOD [Department of Defense] was also listed among several others e.g., NSF, Smithsonian, DOE. Having those agencies come together and coordinate how they spend their money on global change information andglobal change research. So that was the beginning of the US Global Change Research Program. It really got underway in the '90s. It was a key coordination activity within the government. The importance there, too, is it was a way in for the international community to see how the US was coordinating amongst the agencies because if you're trying to set up agreements with data exchange, information exchange, it's nice to be able to know where to go to as opposed to going to ten or eleven different agencies. You could come to USGCRP, explain your idea of what you're trying to accomplish, and USGCRP could then coordinate it. That came to be extremely important because the IPCC, Intergovernmental Panel on Climate Change, was formed about the same time 1990, 1989. IPCC was the body that was to do the assessment of climate change not across the US, but across the whole world. One of the things that USGCRP was able to do then is provide the scientists that were needed to help the rest of the world analyze what we know and don't know about global climate change because we had all the agencies at the table and they could vet the scientists that could best fit into this IPCC activity. For IPCC, there was understanding the climate part, understanding the impacts, and understanding the mitigation. The way IPCC worked, the scientists did the assessing. But once they did the assessment, it had to be reviewed by their fellow scientists, had to be reviewed by the public; the public had an opportunity to look at all the science. It was reviewed by each government, called the government review. Then the scientists and the government after passing all these reviews, would come together, and the government would sign off line-by-line on a summary for policymakers. The underlying work was written by the scientists and not touched by the governments, other than they could review it and scientists would have to respond. The summary of policymakers was initially written by scientists, but then the government officials would go over sentence by sentence to ensure what was said they understood, challenged the scientists whether it made sense, and the scientists would always have the final word as to

whether or not any changes in the summary for the policymakers were still consistent with the science. So, it was an interaction between the scientists and the representatives from all the nations of the world that would come together for these meetings. So that was a critical component. The IPCC reports were done, on the average, about once every five to seven years, and it really ended up being an ongoing process because as soon as one was finished, you'd start a call for authorship and outlines for the next one. So, it was an ongoing process. The IPCC actually has its own bureau in Geneva, whereby they help organize these kinds of coordination activities. It was a great chance for scientists around the world to come together and learn from each other. I was fortunate enough to participate in many of those, led a couple of the assessments from the observations chapter, served as a reviewer, and my last one actually was the co-lead of the US delegation acting for the US government, not a scientific author. As I mentioned with the summary for policymakers, one tries to get agreement on each line. Well, I was on the other end; I was the government challenging the scientists, "Why are you saying this? This doesn't seem to make sense," or "if we said it in this way, would it still be consistent with what science that you have?" So, it was interesting. It was nice being able to be on both sides in that process.

MG: I also wanted to ask more about the wave work you mentioned earlier. What did that culminate in? Was it useful to the Navy? How was it used? Did it turn into a report?

TK: Yes. The wave model ended up in a number of atlases. Back in those days, atlases were key because we didn't have computers that contained all this information. So, we put out a number of climate atlases for each ocean basin. The Navy put this on all their ships, so it was used for planning activities. As the '80s went on, CD-ROMs became available. This information was moved on to CD-ROM. Instead of carrying these huge atlases, one for each ocean basin – probably weighing a hundred pounds – and putting them all together, they could put them on these little CD-ROMs, read them right off their computer. So that's how the Navy ended up using that information over the course of the '80s into the '90s.

MG: The other thing you had talked earlier about was the discovery of climate variability through interpretation of the data. Were you seeing that climate was becoming more frequently variable, and that the variables were more extreme?

TK: In the '80 we didn't see that yet. But it did lead to the '90s, and the '90s were really a key decade from the standpoint of really establishing a baseline for looking at some of these things. Remember, IPCC is going on. So, we're asking all these questions. There was also a national assessment that was called for by USGCRP. So that was going on at the same time; that started under Clinton-Gore in the late '90s. I was fortunate enough to co-chair that first assessment. All those activities – IPCC, national assessment – began to lay the foundation. Well, it's not enough just to do a one-off paper [on] what we see for some unusual events. What's happening? Are we seeing trends in the extremes? What are we seeing about the changes in the components of the climate system that we care about and even those that we don't feel but are critical because they actually make up the critical aspect of what we see in terms of weather and climate? So, at that time, we started looking at how we would, if we wanted to, really assess on a regular basis, what the climate was doing. So, at NCDC, we came up with the idea of let's put together a state of the climate report. The idea was we'd put this out every year. We'd lead it from NCDC, but it

would be totally dependent on scientists across the US and across the world because what we would try to do is put together data and information that then, when you are doing an IPCC report or a national assessment, you don't wait six years to look at what's going on; you're doing it regularly, and you're pulling all that data and information together. So, we made an arrangement with the American Meteorological Society [AMS]; they put out the Bulletin of the American Meteorological Society. We said, "What if, every year, we have a special issue of the state of the climate, peer-reviewed." It would consist of – at that time, it was dozens of authors. Now, it's probably hundreds of authors across the world. They agreed that it made a lot of sense. So, we started that activity. I'm happy to report that today it's a key component of what goes out every year from the American Meteorological Society, and a key component of the global scientists looking at extremes and not only what you would typically think of as weather and climate, but emissions, atmospheric constituents, all the kind of global change information that you can imagine that would be important.

MG: When was the first State of the Climate report done?

TK: That is an excellent question. I'm trying to look at the site here to see.

MG: Why don't we pause here just for a minute? [Recording paused.]. I was curious about some of the scientists you worked with in the early NCC days.

TK: In the early days of NCC, I was really fortunate to have some really great mentor scientists, both within NOAA and outside NOAA. That was what was really key. One scientist outside of NOAA – we wrote a number of papers, looking at how temperatures were changing. We found that nighttime temperatures are warming more than daytime temperatures. A lot of scientists were interested in why that was. That was Dr. George Kukla, up at Columbia University. He was a key component of DOE, Department of Energy, funding his work. He looked at snow cover and how that had changed. He was a scientist. He emigrated from Hungary, when the Iron Curtain was about to fall upon them. He emigrated to this country. So, we did a fair number of papers. I think as I mentioned earlier, Jerome Namias was really important in terms of really pushing us to look at the data from the standpoint of how unusual the weather and climate was from the data we had. A number of scientists from University of Illinois were very interested in the data we had; [we] worked closely with them. Stan Changnon was one of them. Peter Lamb and Mike Richmond were others, I can remember Peter and Mike calling me up numerous times; they found an error in a dataset somewhere. What's going on? Can we figure this out? Art Douglas at Creighton University was another one of Namias's students and was always interested in how our data was faring with respect to its ability to put the proper perspective on climate and weather events. There were a number of scientists, in addition, who wanted to look at the data from the standpoint of impacts the data would have on various systems. Some of them were interested in impacts from the standpoint of insurance. Stan Changnon was one of those. There were a number of state climatologists; each state had their own state climatologist, and many of them were interested in impacts, and they would call and request data, asking us to help them analyze some of the data in some cases, given our experience with some of the datasets. They had a lot of regional knowledge as to how the weather and climate conditions would affect conditions in their state. So that was a key component of doing the work. That is working with colleagues outside the institution.

MG: I think Harold Crutcher was someone else I was going to ask you about.

TK: Yes, Harold Crutcher was an individual who was actually inside NCC. He was one of the leading statistical climatologists at that time. He was literally a one-man show. He probably was the most academic and thoughtful person that I've run into in terms of unique ways to analyze the data, looking at various statistical distributions, trying to figure out, in particular, precipitation, how that is distributed in a way that we can predict what we're likely to see in terms of extreme events. So Harold was almost before his time. Had he been, in his heyday in the early 21st Century, I'm sure he would have been a key component of the global change contingent.

MG: You were talking about the IPCC and the USGCRP earlier and the history of those committees. When did your involvement with them begin?

TK: I began with IPCC at the very, very beginning. Kevin Trenberth, who was a researcher at the National Center for Atmospheric Research, who's extremely prolific, publishes more papers than any person that I know of. He was initially asked by the USGCRP, IPCC to participate in the first IPCC document, and he said, "Boy, I would love to do this. I know it's extremely important. I'm just way too busy." He had worked with me prior in the '80s and said, "Why don't you give Tom Karl a call? He might be interested in helping." That's how I got involved. It was a great relationship because my colleague, Chris Folland from the UK Met Office was a co-chair that I worked with during a number of the assessments. We ended up with a great relationship. He had a fairly extensive group analyzing ocean data. We had a lot of interactions between his group and our group here at NCC/NCDC. So, it was fortuitous that Kevin got me engaged. But I was very thankful.

MG: You also talked earlier about the organizational structure of NCC and NCDC. How did you interact with the other branches of NOAA? I imagine there was lots of engagement with OAR [Oceanic and Atmospheric Research].

TK: It was an interesting relationship, because the Weather Bureau, which became the National Weather Service, obviously, was the feeder of much of our data early on in the '80s because all the data they collected ended up in our building and our data files. As time went on, that began to change; they still were a key contributor, but satellites became more and more and radar data. Radar was operated by the Weather Service, but we also brought in radar data from other countries as well. So the Weather Bureau was still key, and the Weather Service was still key, but there was an expansion in where the data came from, [including] internationally. There were programs in the USGCRP that said, when you have a research program that goes out and collects data, do not throw it away. That data needs to be saved because others may want to look at it. So, we have more and more data coming into our center at NCC and the other data centers in other agencies. Then you came up with issues of is there going to be funding to hold this data and store it?. That was where the USGCRP program came in and NOAA's Global Change Program that Mike Hall ran. He provided the opportunity for us to provide the resources to bring some of those critical datasets in, certainly not all data, but some of the data. Paleoclimate data, for example, was extremely important to understand what's happened not just in the past fifty years, but the past thousands of years. Mike had a paleoclimate program that enabled us to bring

in paleo data [inaudible] and give access and a better understanding of what the climate was like back in not only recorded history but pre-recorded history as well.

MG: That's really fascinating.

TK: I should just say, paleoclimate data, what is it? Well, these are proxy data. The data are not observed by instruments, but they're measured after the fact. So, tree rings, coral growth, sediments in the bottom of the ocean, varves taken from ice sheets, for example, you can look at the composition of those ice crystals going back in time – pollen locked in soil is another example. There was a joke about rat middens, rat poop in caves. So, there's many different types of data one could use to try and assess what happened back in the past and save all that data and make it accessible as part of that paleoclimate program.

MG: How did the ingestion or creation of data change in the 1990s with the Modernization and Associated Restructuring [MAR] at the Weather Service? Was it more refined, more abundant? Also, how did things change during the era of computers?

TK: One of the major – you asked about the interactions within NOAA. Because the Weather Bureau was providing the data to NCC, you can imagine some of the tensions between the institution providing the data and the receiver. If you're getting the data on punch paper tapes – this is how we recorded our high-resolution precipitation data – it takes a lot of work to read those punch paper tapes and convert them to real numbers that a computer can read. So, we would have extensive communications back and forth. "Can you give us the data? Can you provide us the data in a form that doesn't require us to invest a lot of dollars?" We had things like punch paper tape readers. There were none of these things in the world. We had them for quite a while until eventually they got digitized. But it was this back and forth. Instead of sending us paper records, let's figure out howyou can send it on magnetic tape. So there was a considerable amount of interaction between the Weather Service and NCC. But it wasn't just the Weather Service; it was any group that was providing us data, even within NESDIS – the satellite data. How's the satellite data coming down? It's coming down at these ground stations. Well, how's the data from the ground station coming into NCC? What kind of communication bandwidths are we going to have? These were critical components of developing a system that would move data from the observing system to the archive, and then provide access to it.

MG: How was your role changing in the 1980s? I know you went from researcher to lab chief. Which lab was that? Tell me about that role.

TK: I ended up going from researcher to – back when the Global Change Research Program was announced and the IPCC – back around that time, NCDC as it was called, said, "Well, we should probably form a global climate laboratory. Take a number of our branches and focus on global climate in terms of using the data to assess not only what's going on here, but what's going on globally." So, when they did that, I was lucky enough to become the lab chief for that program. That didn't last long because it seemed like once I had that position, Greg Withee, who was the director of NESDIS said, "Can you come up to Washington, DC and help me because I'm working with Mike Hall. I've got not only your data, but the data from the oceans and the geophysical data to worry about. Can you help up here?" So, I would shuttle back and forth

from Asheville to DC to help him with that program. Over time, like six months, nine months, it was clear that that was pretty much a full-time effort. But I also didn't want to lose my scientific roots. So that was key. I said, "It was key to helping you, Greg, with your program." So ,he agreed that maybe a new position, a Senior Scientist position would be appropriate. So, I left my global climate lab chief position, became the senior scientist for NCDC. That was in 1992. I was in that position for six years. That was a great opportunity for me to help not only NOAA and NESDIS with the data problem, but then up it freed me up with a lot of the administration responsibilities, the management responsibilities because as senior scientist, you didn't have to worry about fifty people reporting to you. You had a secretary to help you. That was it. That was a great opportunity to bring in both the science and help with these programs from IPCC national assessments, helping Greg with his data and information program, and working with Mike Hall and his program. It really gave me great insight into some of NOAA's gems and some of NOAA's problems.

MG: Do you want to share any more about the gems or problems? Are there examples or stories that come to mind?

TK: Well, I think the gems at NOAA were these people were working on these datasets that – Syd Levitus was a good example, working on developing ocean data, subsurface ocean data that nobody believed was in good enough shape to really say anything about what's happening in the deep oceans. Syd put his nose to the grindstone, as they said, developed a wonderful dataset, one of the first reference datasets. In the '90s, I think we brought to the forefront the notion of reference datasets. These are datasets that have been quality controlled. They've been looked at. The tires have been kicked. The car has been driven. So, you know where the problems are. It doesn't mean they're perfect, but it does mean they've really been assessed. We think we understand the uncertainties in the data and the biases. So, in the '90s, [there was] recognition that there were a number of opportunities for reference datasets. That included upper air data. It included ocean surface data, as I mentioned, subsurface ocean data, tide gauge data that the National Ocean Service had collected for many, many years. Now it can be used not just to measure the tides, but to look at sea level and how that's changing. Other datasets that really began to be important were some of our satellite data because if you wanted to look at what was going on globally, you had to have global observations, satellite data able to measure and look at hurricanes across the globe. Another reference dataset that was developed with respect to the sea level pressure, the winds that drive the weather – great opportunities from satellite data. I mentioned that we used to work with the Spectral Ocean Wave Model. Well, now, with the new satellites coming on, they were now beginning the capability of measuring wave heights that you could rely upon. Now you've got some verification beyond ships, where ships go. But satellites are able to look at areas where ships are unable to go. So, the gems were these new datasets that were a great opportunity to understand the climate and weather and other geophysical phenomena across the world.

MG: What about measuring the ozone layer? Growing up in the 1980s, I remember hearing a lot about the hole in the ozone layer, CFCs [chlorofluorocarbons], and things like that.

TK: Yes, that was another case where perhaps, NOAA at that time – Susan Solomon was probably one of the more famous scientists, along with Dan Albritton. Dan Albritton led the

Aeronomy Lab for many years. He had a knack for being able to succinctly summarize what we know and don't know, probably better than anyone I've ever met. He can do it and in cartoons on, at that time, transparencies. It was just phenomenal how effective he was. Well, Susan worked for Dan Albritton. Susan was instrumental in making some of the discoveries in understanding how the ozone not only was formed but was destroyed. Obviously, it was an effort that was not just NOAA scientists but scientists outside of NOAA. The Nobel Prize was won that year – I think it was 1988 – for discovering components of the ozone hole's destruction. One of the nice things about that story was there actually was a solution. We understood why the ozone was being destroyed – chlorofluorocarbons – and we had ways to prevent chlorofluorocarbons from getting into the stratosphere and destroying the ozone. One of the good lessons out of that was being able to monitor over decades and see how that changes. It was really the first global monitoring effort that was a precursor to the global monitoring for the broader global climate change, global warming, and climate change issues that we face today. The ozone hole monitoring was perhaps the first to show you can actually monitor globally, see how it changes, and you can actually see how you can fix the problem.

MG: What came of the Global Climate Laboratory? Is it still in operation?

TK: It's not still in operation. It's been transformed. When I was at NCDC, until about 2013, NCDC was a unique entity. But about 2013, there was a reorganization, and the reorganization was to develop a National Center for Environmental Information, which would be composed of the three data centers: geophysical, oceanographic, and climate. So, the global climate lab really moved into the weather and climate arena. Right now, it's called the Weather and Climate Center in Asheville, and the Global Climate Lab essentially became absorbed into that component. So, it has critical roots. But, as an entity, it's not what it was back in the '90s.

MG: I know that your work with Mike Hall and the Global Climate Laboratory led to some international work and opportunities. Can you say more about that?

TK: Working with Mike Hall in NOAA, and his established a team composed of NOAA scientists and scientists outside of NOAA to help him and advise him on how best to spend the dollars that Congress provided for the global climate program that he managed. This was kind of unique in NOAA because up until that time, the dollars had gone into each line office, and they decided how to spend the resources. So, this was a little bit different. It made sense because the global climate program reached into each line office. So, putting it into – I should back up. The Global Climate Program is in OAR, which is the Ocean Atmospheric Research program. But the global climate program was partitioned off. It was pretty much a silo because Congress had specific funding for that program. So, in that sense, it was a unique program and touched all the line offices. This advisory board helped Mike Hall decide how best to spend dollars. The advantage of doing that both within NOAA and outside NOAA, having this advisory group, [inaudible] some great advocates for the program because they were also responsible for ensuring high quality and getting that good bang for the buck for that program. So that program is still going on today. The Climate Program Office still operates at NOAA. It's a key component of funding for many of the critical programs that NOAA is involved in today. That includes things like developing those reference datasets I mentioned. In addition, it also includes funds that were allocated for a climate reference network. So, one of the interesting stories is as

you're developing climate reference datasets, you recognize, boy, if we just had observing systems that were dedicated to not just monitoring today's weather or climate, but what about monitoring over decades? Would you do some things differently? Yes, you would often do things differently if you knew you wanted to monitor, over decades, as opposed to just give me a snapshot today and last month. So, from developing those reference datasets, we recognized there was some need for reference observing systems. So, NOAA actually got in the business of developing reference data systems. We at NCDC, at that time, developed something called the Climate Reference Network, which is a series of observing systems from Alaska down to Florida, with the notion of we want to really measure temperature, precipitation, ultraviolet radiation, soil moisture, wind speeds for many decades and putting in systems where we knew if we made an instrument change, we knew what effect that had before we put the change in. We knew any biases that were in that network. If there was encroachment by civilization in these observing systems, we knew about it because we monitored what was going on around those systems. One of the nice things that happened at that time as we were developing, other nations also realized this is really important as well. In fact, we exchanged some of our instrument sites with Russia; they put in a station. We could compare our data to some of their data. Other nations, Canada, did some similar things. So, we had a lot of interest not just here but across the world in developing reference station networks. The World [Climate Research] Programme became very interested in that, which is part of WMO, and really advocated for all the countries developing research systems. So, let me just step back a second and say a real impetus that also developed along with these reference stations [was] something called the Global Climate Observing System. This was an international activity with the idea that we could put together all these reference systems and make a real global climate observing system. Because at that time we had a weather observing system, not a climate observing system. So, there were numerous meetings internationally to figure out how we could best do that. A lot of agreements were made. It was such a great idea that not only do we do a climate observing system, but a terrestrial observing system, an ocean observing system. These were activities that often were chaired by scientists outside of government, but internationally organized through the WMO, the World Meteorological Organization, to try and coordinate amongst the different nations. From my standpoint, I think there were a lot of great successes in that program, and they're still going on today. I wish there could have been more. We are always looking for additional resources. I know Kevin Trenberth and I wrote a paper that we published, and we tried to try to estimate how much money would be needed. The order is close to a billion dollars. It was very hard to come by that amount of money at that time. So, we made incremental progress. For that, I'm very grateful that we were able to do that.

MG: Was this in partnership with NASA? I have in my notes something about the Earth Observing System Data and Information System?

TK: Yes. NASA was involved in the Global Climate Observing System, but NASA had their own Earth Observing System, which was really focused on their satellites and using data from their satellites, in particular, and they formed a number of information centers across the nation. But their focus was primarily their satellites.

MG: What else stands out to you in the first decade of your career at NCDC? Are there any other stories we're leaving out or anything we're missing up to this point?

TK: I can't think of anything. Well, I can think of one thing that was pretty unique, and that was Danny Mitchell, who was the director, really was aggressive at bringing in talent outside of the center, bringing in a lot of young, well-trained scientists who normally wouldn't have been at the Climate Center, and they stayed on for sometimes six months, sometimes several years, and really infused a lot of new ideas. Some of them stayed on permanently. But he was a strong advocate for bringing in that outside expertise. That included not only Ph.D. students and postdocs but professors from different institutions. That really set a precedent because NCDC and I think the other data centers subsequent to the '90s have brought in a number of people to work because you're right there with the data, talking to the scientists – great interactions. We brought in scientists in the '90s and the 21st Century, not only from other components of NOAA but internationally. We brought in a number of international scientists who spent anywhere from six months to a couple of years working with us. Sometimes, we had people stay permanently, get their green cards, and work with us.

MG: This just popped into my head. When I've done interviews with folks who are in the Weather Service, they talk a lot about the public-private partnerships. Did that play a role in your work or the NCDC's work in terms of sharing information and engaging across the public and private arenas?

TK: That's a great question. Public-private partnerships were really front and centerpiece in the 21st Century. Where we had some great public-private partnerships with the insurance companies. We had numerous meetings and workshops, where we'd have representatives from a variety of insurance companies come talk to us about our data and how we can use it. At that time, we were just developing, in the '80s, what we called the billion-dollar disaster dataset. Because we have data from the Weather Bureau and the Weather Service showing the impacts of storms on the economy, and we worked in the Department of Commerce, we had the bright idea of why don't we put this data together and look at it over time. So that was developed in the early '80s. I wasn't a key part of that, but the number of scientists in the user group. Neil Lott Watt I think was a key person who worked at NCC. Later on, I really encouraged him and others (Adam Smith) to continue that and expand it, but it was his initial idea. We had a number of workshops with insurance companies, who then began to do this as well. Munich Re, in particular, is doing it on their own because they recognize how important it was to look at global disasters to see how they were changing over time. But it wasn't just the insurance companies. I'll give you an example. There's a National Association of Arboretums across the US. Arboretums are often engaging with the public and very interested in weather and climate because they're biological arboretums. All outside growth is dependent on climate conditions. It's also a good opportunity to educate the public in terms of our understanding of climate. So ,we worked closely with the Arboretums, providing them information about what we're seeing in the data, and had a number of national workshops with them. Some of the other partnerships we engage with are the energy industry, oil companies, in particular, consortiums interested not only in the ocean data we have but the heating and cooling degree day information that we calculated and put out not only for this year and last year but as far back as we could go. They use that information extensively to try and ensure that their heating and cooling load requirements are going to be adequate. One of the interesting relationships we had [inaudible] at that time, I believe, was the New York Mercantile Exchange, where bets were made on how much heating

and cooling degree day information there would be – would we have a warm summer? A cool summer? It's still going on today. So, we tried to bring that information, make it more readily accessible, and listen to what their needs were in terms of how they would like that data. So that was an important relationship that really started in the ’90s and has continued on. I can tell you that relationships with retailers – having meetings with retailers who are interested in transporting goods across the country and trying to talk about how we can best provide them with the data that they need was a critical part. We have a number of meetings both nationally and locally. They came to Asheville, North Carolina, to see if they couldn't better understand what we do and how they could make use of it.

MG: In the 1980s, were you also aware or interacting with what was going on at NOAA at-large? I’m curious about the different administrators and administrations and how they impacted your work, if at all?

TK: In the 1980s, I think it was a decade of transition, of recognizing that – the word stovepipe was often used, that the line offices were too stove-piped, and there needs to be more collaboration across the line offices. I think that's where the ’80s built a good foundation of fisheries, not just talking to fisheries but talking to NESDIS. NESDIS obviously, it was always talking to the Weather Service because that's where we got our data, but opening up those lines of communications with OAR, Ocean Service, Fisheries, I think that was an important component that occurred in the ’80s and was highly encouraged by the administrators, recognizing it wasn't quite as easy to do that. We didn't have email back in those days. So, you had communication, either in person or by letter or telephone. But encouraging more of that kind of activity was something that was critical at that time.

MG: Did that have anything to do with the reorg that took place in the late ’80s?

TK: I think so. Well, there's never any one thing that is responsible. But I think it was a recognition that – they called it the Global Climate Lab. “Global” has a recognition that we’d have to be more broad in our thinking. So I'd say yes, it had some influence for sure.

MG: The question I had in my head just popped out of it.

TK: I'm looking at some of the things that I had that I wanted to mention.

MG: Sure.

TK: I want to talk a little bit about – are we still in the ’80s or ’90s? I've been moving around a little bit.

MG: I think we're generally in the ’80s. I was going to ask you next about your role as senior scientist and your priorities, interests, and goals and then developing your career. But if you had something else you wanted to discuss first.

TK: Yes, that'll be the ’90s.

MG: Right.

TK: One thing about the ’80s is I was young enough then. We had some nice picnics with other families at NCC. I can remember that.

MG: I was going to ask a little bit about your life outside of work. Had you started your family by then?

TK: Yes, both my children were with – my son was born in ’82, and my daughter prior to that. So, in the ’80s, they were young. As I mentioned, there were a number of young people that Danny Mitchell brought in. When you're young, what’s the most important thing you do if you’ve got kids? Get them outside, get some energy out of them. So having picnics with your colleagues seemed to be a thing to do.

MG: That sounds nice. It sounds like it generates a sense of community and you can get to know other people. You seem to really have developed your career through partnerships and relationships, so maybe that helped fuel that.

TK: Yes, I think that really had been a key component. I can remember in the ’80s, as relationships were developing, it seemed like there were always guests coming to my house or we were going out somewhere, developing these relationships. Asheville, back at that time, wasn't quite as urban as it is today. So, they’d always be amazed when they’d come down, and I’d take them to some bluegrass and barbecue. We had some interesting restaurants at that time that were unique to this area. They always found that that a lot of fun because it’s something unique here that they didn't have.

MG: Asheville has been on my personal bucket list as a place to visit. I'm sure I would love it there. I just was trying to think about the different administrators who served NOAA during your tenure. There was Anthony Calio, William Evans, John Knauss. Does any administrator stand out to you?

TK: Well, I was low enough on the totem pole back then that I really didn't pay much attention. It didn't faze me that much. I was probably more looking at the next one or two levels above me in terms of what they want. It wasn't until the late ’80s and ’90s, where I became more ecclesiastic in that respect.

MG: Was that a turning point for you? You have the busiest CV. It seems like you were really engaged in so many committees and groups. How were you thinking about your career?

TK: One of the fun things I was able to do is – maybe my first committee was in the late ’80, but certainly in the ’90s, working with the National Academy of Sciences. The National Academy put together committees to look at problems. An agency would provide funding to the Academy and say, “We've got an issue. We need some scientists to try and address it. Can you put together a committee to take a look at it.” So, I would serve on these committees. That was just the best learning experience you can imagine because you are serving with the cream of the crop of your colleagues, and you met for a couple days to really look at a problem and try and

investigate it. The nice thing, having done that, you made numerous contacts that you would otherwise not have made. You come back to NCC with some great insights, some ideas [about] how to not only analyze data but what people are looking at in terms of what data they wanted. So that was a great learning experience for me. I was glad I was able to contribute. As time went on into the '90s, I became fortunate enough to actually chair some of these committees. So, when you're chair, you get to work closely with some people who are actually staffers at the Academy. I recall one of the staffers being Joe Friday after he retired from NOAA. Joe was great because he worked on my committee for a year or so. One of the problems when you're just meeting for a couple days and then you try to put out a report, which could be fifty, seventy pages, is finding the time to do that, putting together all the notes. Of course, Joe had all this insight and knowledge. He was able to put together the notes and put together a draft and send it over to you, and you could read it, edit it in a couple of days, and you'd be done. It was like, "Well, if I could have Joe Friday working on my committee all the time, it would make life wonderful." So that was a unique opportunity, having known Joe when he was the director of the Weather Service, and then working with him in a different context at the Academy. That was a lot of fun.

MG: When did you first meet Joe Friday?

TK: It must have been in the '90s. I can't recall the exact date or time. I certainly heard about him before I met him. I know we talked on the phone. The American Meteorological Society is a place where a lot of people meet because fortunately NOAA sends a number of people to these AMS meetings. At these AMS meetings, you get an opportunity not only to meet people outside of NOAA but sometimes, for the first time, meet people inside NOAA because you haven't had an opportunity to meet them. That was a golden opportunity. I should actually say, AMS has been a key component of my capabilities and learning. I ended up fortunate enough to be president of the AMS and prior to that, served on many committees. I found that experience to be priceless because you really get a chance to meet and talk to numerous people [with] different perspectives. The nice thing about the American Meteorological Society is it's the private sector, it's government, and it's academia all coming together with shared interest. It's a little different than the American Geophysical Union [AGU], which I'm a member of, and I love that society. But AMS is somewhat different because it's not just academics. It's the private sector and government.

MG: You were named an AMS fellow, I think, in '93.

TK: Yes, that was a nice honor to have that. One thing – back at that time, AMS didn't recognize their fellows like they do today. I think they learned a little from AGU because I was a fellow of the AGU, and AGU makes a much bigger deal. They had a dinner and a lot of pomp and circumstance. So, I think AMS now today – there's a special reception for the fellows. But, at that time, I don't recall much more than a piece of paper, which is great. Believe me, I'm not complaining. But I'm glad that the AMS is recognizing the fellows in a much more prominent way today.

MG: Was it in 2009 that you served as president?

TK: Yes, I think. I'd have to go look at my plaque somewhere here. One thing about the AMS, when you're president, it's one year, but it's a four-year commitment. It's two years before and then the year after. So it's a significant investment in time.

MG: I bet. Maybe this is skipping ahead, but I don't want to lose this thread. Were there any major issues in 2009 or during your tenure as AMS president?

TK: Yes, unfortunately, one of the major issues was funding. At that time, there was the financial crisis. So, it was not really the most fun time because [it was] what can we do without as opposed to what can we do. The other thing that was important at that time was this global change issue with respect to Is it real? We've got people saying they're skeptical. They're denying it. There was some animosity within the AMS; some people were turned off by all the global change activity. So, trying to bring those groups together in a way that we could talk civilly and really understand what was going on. Because remember, these weren't just academics. AGU had a much easier issue because these were the people who were studying it. So, they knew the ins and outs. AMS was partially made of academics and government, but there were a lot of private-sector people. They weren't studying this issue, and they were just hearing about it. They were hearing different perspectives. They came to the table a little differently than the academics or maybe some of the folks in government would.

MG: I meant to also ask you about the Global Climate Laboratory and your time going back and forth to DC. I was curious what that was like? What kind of interactions did you have when you were at headquarters?

TK: The airline people got to know me very well. Let's say that. I think I ended up spending more time waiting in Charlotte airport than I care to recall. The advantage is – a lot of these airplane flights are pretty boring – it was a great opportunity to catch up on reading, do some work because it does take a lot of time. I mean, Asheville to DC sounds close, but it's six hours. The flight may only be an hour from Charlotte to DC. Then from Asheville to Charlotte, it's forty minutes. But then you're waiting a couple hours, and you have to be there an hour ahead of time. So, it was a lot of time to spend reading and working. That's what I recall most vividly. What I [found] difficult was I'd always regret those days – Sunday would come. If I had family stuff going on here – "Oh, it's two o'clock. See you later, guys. I got to get out of here." That was the downside. The other downside is coming back on Fridays, the flights being canceled, trying to get a car from Charlotte, coming home at two or three in the morning, and delivering the car. Those are the pieces that aren't quite as much fun as they might otherwise have been.

MG: Had you been hoping to apply for the senior scientist position before it was available? How were you thinking about your career unfolding at that point?

TK: I wasn't thinking about it at all because there was no position at all. It's just something that happened. It was a recognition that I couldn't manage the global climate lab with whatever we had, fifty or fifty-five people, and be the manager that they come to epxpect, and shuttle up to help Greg Withee, and do justice to his program, and also stay in the science as an active scientist. So, something had to change. So, Greg had the idea – "Why don't we create the Senior

Scientist position? Try and keep you engaged as best we can in all these things without the management activity."

MG: In the time we have left for tonight, tell me about how your career unfolded in this new position.

TK: As Senior Scientist, it really gave me a great opportunity to engage not just with NCDC issues but more broadly across NOAA. It really worked because Greg's program and Mike Hall's program are really across NOAA. In the '80s, I had worked a lot outside of NOAA. But the '90s, I'd say, really helped me better understand how NOAA works internally. I remember Greg Withee had me – "Tom, I want you to go to every line office director and talk to them about the data we have, why it's important, and how we can work more effectively together." I can recall some of those meetings – to get on the calendar for a director of a line office, you're going to use an hour or two hours of their time, and some of them were really interested, and some of them you really had to convince why this is important because, at that time, there was concern that now you're going to focus on this data and information. Isn't NOAA a zero-sum game? "Funds are going to make the data more widely accessible. That means the funds aren't coming to my line office." I don't want to say any line office in particular, but I can tell you, I almost got thrown out of some line offices. But eventually, better minds prevailed, we got along pretty well, and I think everyone recognized the value of working collaboratively. It wasn't just about the data in NESDIS because we recognized there were these gems of data in other line offices, and NESDIS, with its climate program money, could help them improve their datasets. I think once you got the sense of trust developed, the programs really took off. I think through the '90s and into the next century, people were strong advocates for data, no matter where it was. It was just hard early on, I think, because of this concern, "Oh, no, [inaudible] be another situation where another stove pipe is being developed, and we won't see the value across all of NOAA?"

MG: Can you talk a little bit about your interests, your priorities, and your goals as senior scientist?

TK: Well, my goals were to try and put our data into the hands of as many people both inside and of NOAA and outside of NOAA as possible and make it so that they can more effectively make decisions in terms of whatever they're trying to do. In order to do that, I wanted to make sure the data we had was as good as could possibly be. There was another goal I had. That was, I wanted to not just provide the data from the standpoint of "this is high-quality data," but I thought it was important for the people who were close to the data to understand what the data is telling them. Is it changing? Is it staying the same? If you analyze the data and begin to see patterns, is it a real pattern? Or is it an artifact of the data themselves in terms of you're not seeing a real change; you're seeing some artificial pattern that has nothing to do with the real world? I wanted to make sure that didn't happen to us. So, one of the things that was occurring up until that time is a number of people recognized that it was important to correct the data for random and systematic errors, but when they did it, they would find what they thought to be an error, a systematic error, [and] put in what they thought would be the best estimate, maybe note it, "This is a correction that we put in," but they didn't explain how they did it or why they did it. I thought one of the more important things we can do – because computers now are going to enable us to be objective in how we make these corrections and why we make the corrections.

So I had learned a fair amount from Murray Mitchell, Jr, who worked with the Weather Bureau before he passed away, in terms of the importance of putting together good reference datasets and putting in corrections. He didn't have the opportunity to do it via computer objectively. Other people had done this globally as well. So I thought that was another important goal. When you monitor the system, if you're going to make changes, do it objectively. So, in the '90s, we developed some capability of developing datasets, reference datasets, that were all based on algorithms that you could look at. This then became extremely popular. We wrote some papers and got them published. Today, it's a cottage industry. Almost every data set that anybody's using, people put together systematic, objective algorithms for corrections to that data set, which you can go in, look at, and understand what they did. There's metadata, that's data information about that data set. If you publish a paper, they want to know where it comes from now and how you made these corrections. So today, it's commonplace to do these kinds of activities. But in the '90s, it wasn't. So that was one of the things that we thought was really important to begin. It fit in really nicely with NCDC because by the end of the '90s when I became director, this was a major focus of our work.

MG: What was the Climate Change Data and Detection Program?

TK: The Climate Change Data Detection Program was a program that we put together using Mike Hall's funds. The idea was, "Let's look at this data and see if we can detect changes, not just monitor. But once we monitor, can we say for sure we're detecting changes that are significantly beyond what we expect from chance alone?" So that program was put together. We got other agencies to join us, [including] the Department of Energy. It was a great opportunity to interrogate the data, but then go one step beyond. That was really an important program for what we did later in the 21st Century, which we'll get to when we talk about the 21st Century, but it is a great foundation for saying what's happening to the climate in a way that's more than just subjective, but objectively saying, "We're seeing changes that we wouldn't expect if there was simply natural climate variability that was occurring."

MG: Later in the '90s is when you started to get on the radar of the White House and committees there. Can you talk about that connection?

TK: Yes. This was around 1997 or so, I think. There was recognition that – the US Global Change Research Program Act called for a national assessment that hadn't been done. So, Clinton and Gore were in charge of the executive office. Vice President Gore was very interested in climate change. He said, "My gosh, we're going to do a national assessment." I ended up getting a call to be co-chair of that assessment and had the great fortune of working with, again, some just brilliant people – people [from the] Office of Science, Technology and Policy; Rosina Bierbaum; John Holdren, who was involved in in those activities. Jerry Melillo was co-chair of the assessment, along with Tony Janetos, who's now since passed away. We assembled a team that had, again, some of the best minds with respect to understanding not only climate, but its impacts on agriculture, transportation, energy – you name it, different sectors. What was really nice is that there was recognition that if we did this assessment, it had to engage people who are in the public sector, who are, quote/unquote "ordinary people," not scientists, not necessarily heads of corporations, but people who have an interest. There were a number of workshops that were held across the US to explain what we were trying to do, really engaging

the public in ways that we thought were important for not only us to understand – because we understand what some of their problems were with respect to how climate may impact them – but they could then better understand what we're trying to do from the standpoint of assessing the climate. So that was a great opportunity to learn. I've been really fortunate in my career, seeing both sides – the scientists trying to understand the data and the users trying to understand the impact on them. Working with both of those sectors really gives you insight in ways that you wouldn't get if you primarily were on the side of trying to understand the impacts, or on the side of trying to understand how climate varies and changes [inaudible] why. But looking at both sides really was unique. I was very grateful for that. I thought that enabled me to do some things that I might not otherwise have been able to do.

MG: That must have made you an effective translator to the public.

TK: Yes, I think so. Everyone has to recognize their strengths and weaknesses. My strength was not always in being able to articulate in a really quick and easy-to-understand manner. There were some people who could do that, like Dan Albritton, who I mentioned earlier. Dan had this gift. He could do this in ways that few people could do. Jerry Melillo was another person who was great at bringing all the information together and articulating it very succinctly. Being able to work with those people was just a joy because you could see your work then being integrated with other work that you may not have been able to see the connections to. That's, as I said earlier, extremely important when you're trying to think globally.

MG: Did it help that these efforts to try and increase public awareness around climate change coincided with El Nino events? It was an opportunity to illustrate climate variability.

TK: Yes. The El Nino event in [1998] was really a game-changer for not only climatologists and weather people, but I think for much of the world because it was an event that affected literally everybody, from flooding to fisheries falling apart and crop failures. It was something that everyone could see. I mean, the wetness and the warmth in many parts of the world were just something we hadn't recognized in a generation. At the same time, there was a recognition that the climate was looking like it was warming. Of course, with the '98 event, it just spiked up. I can recall at that time, Al Gore calling together a group of us – "Come to the Roosevelt Room, and let's have some briefings about what's going on and why it's warming." Back in those days, we put together big posters to try and explain what was going on. PowerPoint wasn't quite yet ready for primetime. But had some meetings with the Vice President to talk about this. I can recall one time the interest got so intense that year – it had to be the year 2000. I had just met my wife. We were on our first date. At that time, we had just gotten these beepers, and everyone had a beeper. So, I got this beeper call Saturday night; it must have been nine, 9:30. I said, "Well, it's nine, 9:30, Saturday night." I was on a date. I didn't answer it. I looked at the beeper on Sunday morning and recognized it was from the White House. I said, "Oh, gee, I wonder what they want on a Saturday night." They were interested in – because it had gotten so warm, the cherry blossoms that year were blossoming very early, and they wanted to know, "Is this global warming? Is this evidence of global warming?" Of course, we had explained that global warming could be contributing to the cherry blossoms, but it wasn't the only reason. That, I think, was an indication of more to come and what questions would occur. We're seeing an event. Is this climate change? Well, it's not so easy to answer binary – yes, it is, [or] no, it isn't.

It's always nuanced. That's where you can get into lots of interesting discussions, questions, doubts about – and we can talk about that into the 21st Century. That's a lot of what we ended up doing. But in the late 1990s, there was this recognition after El Nino, some of these warm years, that there was something going on that was pretty darn interesting and something we probably need to explore more fully.

MG: I think this is an area that I want to dive into in more detail. I'll ask you about your press conference with Joe Friday and some of the data that you referenced in that. But quickly, I was thinking it would have impressed your date if you said, "Hold on. I've got a call from the White House." [laughter]

TK: [laughter] It did later on. She thought it was kind of crazy. She didn't really put it all together because I remember I simply just told her that I was in charge of a group of scientists, and that was about it in terms of what I did because there's no way you can sit and explain all the things I was doing.

MG: I was curious if you had interacted with Al Gore before he became a vice-presidential candidate. He had really followed the climate since he was at Harvard. This was something that was very interesting to him. When he was in Congress, he held some congressional hearings around climate change. That was in 1976, I think.

TK: In 1976, I was still at Research Triangle Park, and global climate change was the last thing on my mind because I was heavily engaged in air quality transport of ozone in St. Louis. So, it really wasn't [on] my horizon. Al was doing his stuff, and I wasn't really thinking about global climate change at that time.

MG: How did that make you feel going into the Roosevelt Room? I get nervous when I have to talk to middle schoolers about oral history. How do you prepare for something like that? How did it make you feel?

TK: Well, the fun thing is when you're talking about weather and climate and getting into the details, you don't really think about nerves too much because you got a great story to tell. I mean, looking at 1998 compared to the previous El Ninos, how warm it was – so nerves really weren't too bad, simply because you were anxious to get your story out. You know where the nerves came in? Is transporting these big placards on the airplane and worrying that they would get really crushed in the overhead bin where I tried to store them. That's where I was nervous. Now, what if I get there and I don't have anything? I was nervous about that.

MG: Were any of these talks in support of the Kyoto Protocol that Gore was trying to put together at that time?

TK: None that were expressed to me. One of the things that I probably was able to do – I think what we were able to do as a center and a line office in NOAA is to stay apolitical, try not to get engaged in one side or the other side, and recognize this issue of global climate change certainly was politicized. I mean, we got attacked for doing some of our science. We've been accused of

all kinds of things, none of which were true. I think you just have to keep your head high and continue to focus on the science, and the science will come out in the end. I think it has.

MG: That's an area I really want to talk about next time, too. Was it nasty during this period, in the 1990s? Were you getting that pushback?

TK: There was always pushback. But it seems to me that it got more personal in the 21st Century than it was prior. That was the unfortunate thing. It got to be where people's careers were being attacked. I know there were a number of emails that people were looking at that people had sent. It just got to be a bit much, I thought.

MG: Is this an okay place to stop for tonight?

TK: Sounds good to me. I can't believe it's 6:08.

MG: I know. [laughter] There's still a lot to cover. I will send you some days and times to get together again.

TK: That's fine. Whatever day you can find, but this is a great time for me if this works for you. It doesn't have to be this day; it can be any day.

----------END OF INTERVIEW----------

Reviewed by Molly Graham 6/29/2022
Reviewed by Tom Karl 7/12/2022
Reviewed by Molly Graham 7/29/2022