Doug Sargeant, August 2010

Topics: Global Atmospheric Research Program, Development of observational technologies, NWS Modernization Systems Development

Douglas Sargeant: Okay, I'm Doug Sargeant. I started out, uh, my career in meteorology in graduate school at the University of Wisconsin working with Vern Suomi, who many people know as the father of meteorological satellites. In the days preceding, —long preceding the modernization of the Weather Service, there was—there were a couple of international programs, known as the World Weather Watch and the Global Atmospheric Research Program. And both of those were in the formative stages, when I was at Wisconsin; and Vern Soumi was one of the major players in those activities.

There was, at the time, uh, an international situation that was fairly tense, as you may recall—some people call it the Cold War—and satellites had sort of come upon us as a shock, almost, in this country. I remember I, I was in undergraduate school when the Sputnik was first launched; and I was quite interested in that, and got involved, uh, in tracking satellites and so on. And I, I worked at the summers at the Collins Radio Company in Cedar Rapids Iowa, which was my home town. And there—they were very much involved in the technology of, communications with satellites and tracking and all those sorts of things.

Well, the upshot of all this was that the president was looking for peaceful uses of outer space—and this was Kennedy. And the result of that, internationally, was to look at programs that would contribute to understanding weather and climate; and for the first time getting global observations. Now I don't want to get bogged down in detail with this but, at that time, the numerical models were just getting to the stage where they could be global—required, of course, big computers and a lot of computation, but it was becoming possible. However, there was no data, to support a global model.

And so one of the objectives of the Global Atmospheric Research Program in the early stages, was to gather enough data and to develop modeling techniques and so on, so that a model could be run on a global basis. Now the, there were lots of observations taken internationally through the program; and became known as the World Weather Watch; which was the World—WMO, World Meteorological Organization program. And they used mainly surface observations, including from on ships and upper air observations based on the balloon technology. And some of those were being taken from ships also, although that's fairly expensive. However, ships are quite unstable in their orientation. So it's tough to measure winds using radiosonde balloons on a ship.

4:49 So radiosondes were sort of the gold standard of upper air observations; and models were constantly measured against their ability to predict the variables that are observed in a radiosonde. The satellite observations were of course radiometric. And in the early days of satellites, uh, they were focused more on things like albedo in clouds and energy budget type parameters. But in the —around 1960 or so, there was this conception of making a vertical sounding using radiometric measurements of different frequencies, particularly on the well mixed carbon dioxide. Where at the

strongest absorbing wavelengths is center of an absorption band, the radiation would be from relatively high, and at more and more transparent, uh, frequencies of the band, you will see down deeper and deeper.

This is a, a bit of a messy problem and actually an integral equation because all of the wavelengths contribute. And the solution to the problem is, to my knowledge, still being worked on in one way or another, as a basic physics problem, a radiating transport problem.

Well, going back to my days at Wisconsin, one of the other graduate student contemporaries of mine was Bill Smith. I don't know if you know him, William L. Smith. He was in a number of positions of responsibility at NASA and so on; had worked a lot with NOAA over the years and he's retired now too. But he did some of the very first work in his thesis using a combination of statistical and physical methods to retrieve a profile of temperature from a set of spectral measurements of radiation received at a satellite.

To get that on a solid basis was one of the objects of GARP. As sort of jumping ahead here, I got up to my ears in GARP; actually in part through Soumi. I stayed on at Wisconsin on the faculty for several years after I graduated there. And in one of the years, I had a yearlong leave of absence in Australia working at an international center; and this was during these formative years of GARP. And that was where I first got to know and became friends with Joe Smagorinsky, who may be someone before your time too, but is well known as the first head of the Geophysical Fluid Dynamics Laboratory of NOAA. So at any rate he was interested in GARP too.

And when I came back after that leave of absence, it turned out that the—in the United States, there was a national committee which he had been—The National Academy of Sciences; which had been setup to develop a plan for U.S. participation in the Global Atmospheric Research Program. Vern Soumi was on that committee. It was chaired by Jule Charney who is also known by a few people in the field as a great pioneer in numerical modeling.

9:43 Well, the first year of that committee was 1969 and it, it had a single person permanent staff in Washington who was Dick Reed, who is also well known in the—in the field; a professor at University of Washington. And when he finished his year, there was a scramble to try to get somebody comparable to go there and continue the work; but there was difficulty in getting that lined up, timing and other things. And Vern Soumi suggested that I go and do that job—sort of a big come down from Dick Reed—but on fairly short notice, I decided to do that and to come to Washington for a year. So I, I came out and I interviewed with Jule Charney at MIT—and a very memorial thing, we spent the interview walking around the campus handing out anti-Vietnam war fliers as, as he was very interested in that. But anyway, he said I should go.

11:01 And so in January of 1970, I came to Washington on a year's absence; and like so many people, I never escaped. In that first year, NOAA was just being formed, and from the previous institution ESSA [Environmental Science Services Administration], who Bob White—Robert M. White—headed; who I met as a student in Wisconsin when he came to give a lecture. One of the

most memorable things about that lecture was—which was an introduction to ESSA—he said, no, ESSA is not a female gasoline. I've always remembered that—for those who are old enough to remember the old ESSO.

Anyway, I came and started working to get the federal agencies, uh, involved in sponsoring GARP. And, uh, the agencies decided that the new NOAA should be the lead agency. And Bob White was the administrator of NOAA and his—

[Pause in Recording]

12:30 Doug Sargeant: Okay, Bob White's principal assistant at the time was one Richard M. Hallgren; and that was when I met Dick Hallgren. And he was responsible, among other things—he was actually Associate Administrator of NOAA, but he was responsible for the Global Atmospheric Research Program, GARP. It—during that year the agencies—NSF and DOD and NOAA, mainly—got enthusiastic about these programs. And internationally, there was a committee which Vern Soumi was also on, and also Joe Smagorinsky. And it was called the Joint Organization Committee for GARP. JOC—very famous at that time; and it had just scientists who were on there because of their scientific capability, and not their political skills.

And the Global Atmospheric Research Program became a joint program of the International Council of Scientific Unions, ICSU; which is sort of the umbrella body that includes things the National Academies of Science and their counterparts in other countries. And so it was a collaboration between governments of countries through organizations; world meteorological organizations and scientific organizations. That was fairly new at the time, and in a way was, something that came out of the old International Geophysical Year, the IGY; which would have been held in the '50s. It was—had been quite successful.

14:28 So at any rate, the JOC had some international meetings and WMO did too. And fortunately, I got to attend those because I was a U.S. staff person here. And they decided the first major program of GARP would be the—it was GATE, the GARP Atlantic Tropical Experiment. Now that was in recognition of the fact that you—most of the heat input to the atmosphere comes with a tropical belt, and in low latitudes where the Coriolis force is necessarily small none of the usual approximations that make our mid-latitude forecasting and analysis worked so well with the, um, balancing of the forces, so called geostrophic conditions. The tropical atmosphere is always on the verge of instability. Winds can't be determined from pressure gradients, they have to be measured.

The other major trouble with models, at that time, was trying to deal with turbulence; the frictional kind of things; and the transport of energy, both momentum and moisture, especially; and heat vertically through the atmosphere. And that was done from the beginning in a process known as parameterization, where large scale variables were used to estimate values for these fluxes of energy and things like that. But in the tropics, that was in a very poor state of understanding. And so the

tropical experiment; which actually was proposed early by the U.S. GARP committee to be done in the western Pacific where the largest transfers occur—but which are very difficult to do experiments in because they're far away on bases and stuff—so the European countries and the United States had an interest in doing things where it would be more practical to get the resources together.

18:24 So GATE was mounted in the tropical Atlantic; to the disappointment of many academic scientist who were very pure, but we wouldn't have had an experiment without this. And we were managed—we managed to get 40 ships and a couple of dozen aircraft and so on. And in the summer of 1974, the field phase of the experiment was conducted with a headquarters base setup in Dakar Senegal—you know, that's a western bulge of, of Africa. And there were all kinds of scientific participation in that experiment. And we managed to arrange to get the, the decision—key decisions made about measurements and flights and routes and stuff to be made by scientists and not by bureaucrats of any kind.

Anyway, I don't want to bog down in that, but I do notice that there's still a paper from GATE published every now and then. The data set is one of the best, ever. And I forgot how many countries participated in it, but very many—most of the ones in Africa by sendng up extra,routine radiosondes and stuff.

19:18 When the end of my year in Washington was coming up, Bob White and Dick Hallgren said, 'hey, you've been working on this—to get this GATE program going all this time. The least you can do is stay for six months and help us get it launched.' And so they asked me to join NOAA for six months and help launch GATE; which I willingly did. And the six months turned into a year; and my—I had already been gone for two years from Wisconsin. And so I kind of got stuck in the tar baby.

But it was actually a lot of fun. And during that time, a lot of new technology was developed, including—specifically for GATE— including what were called, nav-aid or navigation aid sounding systems; which were based on the low frequency navigation systems, like Omega. And the idea is that sondes would be equipped with the radio transmitters, which would send back signals whose Doppler shifts could be analyzed, uh, to determine the, the wind.

[Pause in recording]

21:08 Doug Sargeant: This technology then allowed soundings to be made from ships; including wind, which was critical in the tropical region because you can't infer the wind. And from the airplanes, we had technology on board to directly measure the turbulent parameters so that the fluxes at different levels in the atmosphere could be calculated. And there were satellites, including the first operation geostationary satellite; the precursor of the—of the GOES system. And the geostationary satellites for SMS was the first one where actually the invention, uh, my mentor Vern Soumi, who was also involved throughout during this time. As—I don't want to go into this too much, it's—the details with regard to GATE—but, GATE really did provide a leg up on being able,

then, to parameterize the parts of the globe in a much more effective method, uh, than had existed prior that that time.

22:41 There were other regional GARP experiments during those days, including MONEX [Monsoon Experiment], the monsoon experiment, LPEX [Low Precipitation Storm Experiment], a mountain experiment—interactions with the mountains were also one of the areas of difficulty to be parameterized—and so on. Now all this was leading up from the begging to a thing called the Global Weather Experiment, or in those days—and hardly anybody remembers it anymore—it was called FGGE; the First GARP Global Experiment. And that was based on contributions from all over the world, including global coverage, for the first time, by geostationary satellites.

23:37 Now, I guess I failed to mention that geostationary satellites also—then as now but in a cruder fashion—were used to determine winds from the motions of the winds observed at that satellite, the displacement of features in the cloud field. And so all of the tropics were covered by geostationary satellites by the United States, by the European Consortium for Satellites, by the Japanese who put up their first geostationary satellite specifically for GARP. It was justified on the basis of experimental reasons; although, everybody was wanting to improve this technology for operational use later on. We're used to that. Most people in the field now, through most of their career, these systems have been there. That's where they came from.

24:45 Doug Sargeant: Anyway, there also was the, uh, debut of—by NASA contribution—the TIROS satellite, uh, which provided the very first high quality soundings, uh, from satellite, twice a day, around the globe, with improved radiometers and, uh, more frequencies, higher resolution, and so on.

25:18 Well, the Global Experiment was conducted in 1980—excuse me, 1978 and '79, with some intensive periods which were where there were flights—long tropical flights were augmented temporarily. And they flew out of Mexico and in the Indian Ocean and so on; covering the tropical pacific, for example, for the first time—sort of gathering the first global data set. And it was during this time that both NASA and NOAA were trying to get global numerical models to work. And they had been built up using the GARP data, and the operational satellites were the basis for an operational system at NMC [NWS's National Meteorological Center], as it was called.

26:42 And Bill Bonner was the—then the—well, I guess he had been all along, previously—the head of modeling at NMC. And at the very—this very time, he was Deputy Director of the National Weather Service under—guess who? Dick Hallgren, who had come over from his NOAA post to take over the National Weather Service. And he had this dream of modernizing the Weather Service. One day, over at my job—by that time, I was the Director of the World Weather Program Office at NOAA headquarters, and was responsible for both the Global Research Program and the operational activities.

Well, Bill Bonner showed up on my doorstep one time, and Dick Hallgren called me on the phone and stuff and they said, 'hey, we need you to come to the Weather Service to help us introduce this

new science and technology into operations.' Well, I had been trained as meteorologist but I had always been—from my days at Wisconsin—more heavily into the technology and observing systems and modeling and stuff; and never in operational meteorology. So I came to the Weather Service mainly because they enticed me by saying I could be the Director of the Office of Meteorology and Oceanography, the operational headquarters group; which I don't even know what they call it now. When I left, it was still the Office -- They dropped oceanography and did it separately. It was OM, the Office of Meteorology. And there was a Hydrology Office.

29:04 Anyway, when I got there, Dick Hallgren, had been for the preceding couple of years, trying to get automation into the field offices of the Weather Service. And there was a program known as AFOS—you're, you're old enough to know. And AFOS stood for Automation of Field Operations and Services. And the most visible part of AFOS was the computer systems that would go into the office. And they had—Hallgren and company had a contract with, I don't know—Data General or somebody, I think—for the computers to go into the field offices and for software to handle all the diverse data coming in, including radar data. I'm almost losing track of all the things that we were doing then because the NEXRAD system was also spinning up at that time using Doppler radar to measure winds at locations where you could have fixed radar.

30:38 Anyway, the company that was manufacturing the computers went belly up; and in the middle of the program. And the Weather Service ended up getting the responsibility for the software for the system. And that whole thing turned into a real nightmare. And I still remember, when Dick Hallgren came to my office and said, 'hey, we really need you to go and help get the Automation Field Operations and Services working. And so he made me the head of—I don't know what the old systems office was called.

Barry Reichenbaugh: Systems Development, right? Office Systems Development, OSD?

Doug Sargeant: It was—I think even before that time it was called something else.

Barry Reichenbaugh: Okay.

31:52 Doug Sargeant: But anyway, uh, at that time the, uh, current head of it was nearing retirement and so Dick said, I'll give you that office and try to get resources together and see if we can't get this straightened out. So I moved to head what became the Office Systems Development and—gosh, I guess that was, uh, in 1979.

[Pause in Recording]

32:44 Doug Sargeant: Okay, I'm starting again after a hiatus here. I don't remember exactly what I said; but I do, want to recall that during—well, any period, but certainly during this period—there was a lot of turmoil in the federal government and budget issues and things like that. And we gave a lot of attention to how to structure a program that would allow us to make the really major investments in technology that was required. And during this time period, we hatched this idea of

the modernization and restructuring of the National Weather Service. And we identified a number of programmatic elements to it that had heavy technology elements to them; which included, of course, computers and modeling, which were central.

But also central and quite expensive were the observations that had to go into that and the various kinds of processing and analysis that were required to make the kind of observations that we could make compatible with the models. And so there was a, a very active period of time of developing, concurrently, observing systems and analysis systems; which would allow these observations to be successfully incorporated into models in a way that you could get the information inherent in the observation and minimize the deleterious effect of all the noise that in, especially, in the remote observations; which were really, really important when you go to a global scale.

35:15 So what we emphasized in the modernization program here in this country were, one, automating the surface observations. And that was very important in the overall promotion of the programs because it allowed a program to be put together to reduce the number of field offices and the staffing levels that were required especially to make surface observations. And the— that program was called ASOS, was, you know, ginned up to deal with that and to, at the same time—from the standpoint of those of us pushing the program—to allow a sort of shifting of more of the Weather Service workforce to be professional meteorologist and fewer to be met techs doing observations.

36:37 Well, this was a, a long effort; and had many elements into it. I don't want to go—divert into that right now. But Steve Short—who you probably know even now, in dealing with the Weather Service—became the director of a sub element of the Office of System Development, which I was heading at that time, to deal with ASOS as it was called — Automation of Service Observations Systems.

37:22 Okay, the upper air observation part of the program was driven on land in the early stages by use of the navigation aid type technologies that had been pioneered in GATE, and using the so called Omega navigation system. And, uh, that system eventually evolved to the place where the GPS navi-type sondes are used to track balloons going up. And so where—in the early stages, the balloons were tracked with radar, mainly, and then later with satellites. And of course if you can do it with satellites you can do it from mobile platforms at sea and from sondes that could be dropped from airplanes. And that was done in -- the technology was proven in the GARP experiments.

The other main element in the modernization of the Weather Service was the NEXRAD Program. And of course radars had been involved in the Weather Service into the '50s; but with Doppler technology evolving after that it finally got to the stage where we could put those in the field. And so the NEXRAD Program was established under Tony Durham—if you may remember that name or not. He was a, a NASA technology expert. And he was especially experienced in the acquisition of complex technological systems from the private sector. And it was during this time period that, with encouragement of the administrations in power, we made a shift from the Weather Service building everything itself, to buying systems from the private sector on the private market. And a

big program to do that was established called NEXRAD. And the NEXRAD radars with Doppler capability that could of course get winds by tracking balloons from the ground was made possible and on a broad basis. And we managed to get a network established across the United States at that time.

40:57 The technology at sea for tracking radar balloons is very complex. And in GATE, you had—we had to use stabilized platforms where we could—on ships, to get real radar tracking of the balloons. And it was only with the use of satellite navigation systems could you make that system more broadly used. And that, of course, is incorporated into the World Weather Watch is globally known as part—a big part of the global observing system is, actual ground truth for satellites from radiosondes that are tracked by navigation aid systems. But that's much more, resolved in the vertical, by far, than what you can get from tracking cloud elements or even patterns of, of refractive index differences, which you can see in different wavelengths. So both remote sensing and ground truth were critical, to that development.

42:25 When we then got into the national modernization and restructuring, there were these key technological observing systems; the Automated Surface Observing Systems, the upper air observing systems, including tracking by satellites, and the NEXRAD system, which provided the very high time resolution that was needed to do warnings, especially. And so along with the—in the early development of what came to be known as the MAR, the Modernization and Restructuring, it had to have both, because the administrations wanted us to have fewer offices. So we had to restructure. There was a good tradeoff in that, as we got to upgrade the staff to professional meteorologists in more offices. So we sort of cut the total number of Weather Services Offices—field offices—in half; but we doubled the number of offices that had high technology and professional meteorologists.

43:55 Doug Sargeant: And so, we ended up with like 100 field offices as a result of that set of changes. Also at the same time, when I was head of the Office Systems Development for a number of years there and we were not only working on getting more, more observations, higher resolution in space and time, and more automation; but new ways to extract the information from these data. And of course from the days of GARP and FGGE, the World Weather Experiment, and so on that I talked about—which occurred in, the late '70s, and where the modeling part was really led by Bill Bonner—the models were—became more and more attuned to use automated data which had a lot of noise in it; to using advanced techniques of data assimilation, using the computers to get the information out.

45:30 Now at the same time in the Office of Systems Development, the Techniques Development Laboratory, TDL—which existed for many years and still exists in a new name, the Office of Meteorology, I guess, under Bob Glahn. Bob Glahn was a director even then. He was fairly senior when I came into that office; and he had already developed the MOS method, Model Output Statistics, where computers were used and sort of advanced regression techniques, to obtain observations of -- synthetic observations -- of variables that weren't observed by the observing system by using statistical techniques. And these, these techniques became incorporated into the

analysis of the, especially, the surface space observing data to make input for the—for the models. And then various elaborate schemes—I don't want to get into all the naming, terminology and stuff. But there were optimization techniques used to get the most information out of the different sources of information to provide the input into the models to the point where the systems evolved even while I was still working ten years—

Barry Reichenbaugh: Twelve.

Doug Sargeant: Twelve years ago where this sort of a continuous cycle going where the models and the observations are sort of continually assimilating each other and getting the most information that anybody had figured out how to get by that time—and still the case now from the combination of the observations and the numerical models. And of course throughout this time, the numerical models were being improved, especially at the National Meteorological Center, to be able to use all these new kinds of data and input.

[Pause in recording]

Barry Reichenbaugh: I'm curious I guess. At some -- obviously with the beginning of the modernization and associated restructuring there was a plan developed. The plan had to evolve some over the early years. Could you talk a little bit about, your input in the development of the plan, and just then the carrying out of the plan?

49:01 Doug Sargeant: As you can imagine, it was a complicated -- a complicated evolution because of many reasons. One was that technology kept evolving and providing new opportunities. Secondly, the costs of a lot of the technology were high by normal Weather Service standards. The government environment was evolving all the time. And particularly, we went through periods where the political forces that governed the NOAA and the Weather Service were interested in getting the government out of many elements of development, and -- and making their own systems and so on, and privatizing things.

And so there -- you know there was a cross current of a lot of forces that weren't just technological to deal with. And so many of the programs that we developed and evolved were sort of keyed to an assessment of what was possible to do. And there were trade-offs between what was done in the Weather Service and what was done in the private sector. And in fact during that time, I probably -- I probably should be wary of getting too much into this. But there were experiments kind of of trying to get things done in a private sector that didn't work out very well. And ..where the technological expertise had to be combined with an understanding of how the meteorological and oceanographical physical system works.

And how the data are actually used and so on. And it was kind of a tough period in there in trying to get through when administrations at high levels in the government was trying to get the government phased down out more and the private sector phased in. But there were a lot of limitations on what the private sector could do. So there was a fair amount of experimentation that went on. And there

was a lot of times in which things had to be either redone, or done on the side, or done on a shoestring, or so on even though somebody else was being paid to do it.

52:21 Doug Sargeant: I don't want to get into those details, 'cause they'll probably just be points of argument. But during that time period, uh a thing I think that was noteworthy was uh, we established a program in the environmental research laboratories uh, which came to be known as PROFS. Which was uh, became the -- the staging ground for all sorts of things. It was headed by Sandy MacDonald [Alexander E. "Sandy" MacDonald], who had been a Weather Service guy before and understood Weather Service issues. And he became a director of that program. And so many of the uh, evolving elements technological and modeling could be dealt with on a trial experimental basis. Especially we used a lot of times the Denver forecast office to do the development of both new technology, and the integration of technology, and the development of algorithms, and things like this which was more acceptable to be done in the research part of NOAA than in the Weather Service.

54:09 Doug Sargeant: So, I don't know whether I should be more specific than that. But, it got kind of a technology transfer type of arrangement going, between the environmental research labs of NOAA -- especially Sandy MacDonald's program which was called PROFS at the time. And the National Weather Service with staging -- a lot of staging done at the Denver office. It became a technology transfer uh, kind of arrangement. And of course as you know, Sandy McDonald's still quite active at this time.

Barry Reichenbaugh: Maybe this would be a good point to ask. As I mentioned earlier, I spoke with Carl Bullock and Denny Walts. And one of the things that had come out in my talking with them; particularly I think I remember Carl saying something to the effect that Doug had a roadmap in his mind for how we would go about this. And uh, I'm just a little curious. You know? I mean obviously your -- your early involvement in the global uh, observation aspects, and your background in experience I'm sure contributed to your abilities to help forge what became the modern Weather Service.

Doug Sargeant: That's true of Dick Hallgren also.

Barry Reichenbaugh: Oh absolutely. And I really look to uh, kind of get that when we eventually talk.

Doug Sargeant: Yeah. Both of us were trying to -- in the modernization of the Weather Service, trying to get the benefits of the technology which had been developing in research programs like GARP into practice in the National Weather Service. But of course, an operational system has many constraints in it. That in order to do that, you really have to -- and since it's done by people working shifts and so on, and because operational forecasts and other products are going out all the time; you have to have reliable products throughout. And it has to be able to fit into the work patterns and work schedules of operational people. During this time period; and actually this was a part of our plan too, was upgrading the work force in the National Weather Service so that the people in the

field offices would have the background and skills to be able to take the new tools and, put them to use.

57:35 The met techs in the early days of my career were very, very skilled. But they had very limited theoretical background. And they -- lots and lots of what they did was based on experience. And uh, as we were trying to introduce more science and technology into the field operations, uh the -- this was really tough for the med techs.

Barry Reichenbaugh: Mm-hm.

Doug Sargeant: And so one of the basic threads was to try to upgrade the workforce at the same time. And uh, there was both a combination of med techs getting older uh, and getting to the end of their career. A lot of them having originated in the Weather Service and so on. And then other met techs were quite interested in meteorology, and upgrading their skills, and becoming professional meteorologists. So we had to get more meteorological jobs in the system as a part of that. So part of the modernization and restructuring was converting the field structure so they had more meteorologists in it so they could handle the science and the technology that was coming along. Not just the observing systems, but the models, and the interpretation of the models, and so on.

59:20 The roadmap that we had in mind was to achieve a synthesis between uh, models that ran on computers and observations that could be made semi-automatically uh, with the human efforts shifted more toward the interpretation of what came out of the bottles. And the providing of services, and advice, and guidance, and so on to the customers of the Weather Service. This was a little bit of an uphill battle because it came at the time when some of the political forces at high levels in Washington were not anxious to increase the work that was being done, by the government. Even though we firmly believed at the time this was in the best interest of the country. But of course we had to follow both the guidance and the budget limitations that came along with the powers that be at any time. So it's kind of a confession to say that what we tongue and cheek called the MAR -- the Modernization and Restructuring, was kind of a dynamic program to take advantage of what the political forces would give us. And to introduce science and technology into all of Weather Services as much as we could, and as much as we could afford, and as much as we could develop the skills of the work force.

1:01:32 But all of those went along at the same time. Upgrading the work force, consolidating resources in the offices, automating observations of all sorts, being able to process the data, getting better models, getting better interpretation of the models both by better training of the people and by developing computer-based technologies to interpret the data from the models better, and so on. And all of these things flowed along concurrently and superimposed on them, an the annual budget cycle, and changes in Administration. Every two year elections of a new Congress, and every four years you know, an election which in some cases was very helpful because a new Administration wanted something to do. And then we could you know, push something for a time. But it's kind of one of those schemes where it's the art of the possible.

1:02:48 Doug Sargeant: You had to figure out, from a strategic level you had to figure out what it was that best met the needs of the Weather Service that could be sold. And figure out how to sell it.

Doug Sargeant: And in some cases, like you could imagine that not everything about restructuring the Weather Service and reducing the number of med tech jobs, and things like that was welcome to everybody -- including some med techs who didn't want to be meteorologists and so on. So you know, there was a lot going on.

1:03:32 Doug Sargeant: And there was kind of an optimization process of changing the system kind of at the rate that it could accommodate on the one hand, which was kind of governed by how the people in the Weather Service could accept it. You know, to some extent there were quite a few people including, Dick Hallgren, and myself, and to some extent Bill Bonner, and Joe Friday, and so on; who came into the Weather Service viewed as outsiders with agendas -- which in fact we did have. And, but we tried to learn to not be ignorant of all the good things in the Weather Service. And there were many, many and are many, many -- particularly their work ethic and the service ethic of the meteorologist. And to, understand and take advantage of that, but at the same time to bring to bare the powerful new technologies of observing and modeling and analyzing and so on. Now during that time, it was my vision of the world. And this was pretty much shared by both Bill Bonner and Dick Hallgren at the time. Was that the observing and forecasting are sort of two facets of a single thing. And the process of making data in the first place, which I'm simplifying an observation and then making forecasts based on those data -- both were greatly assisted by automation. And that computers allowed you to extract much more information out of what was in the raw observation, which you know was sort of determined by the physical nature of the instrument and the -- the aspect of the atmosphere that that instrument was sensitive to. And in the case of remote sensing, almost never one of the variables in the standard equation is emotion. And then on the other hand, the forecasts that are made by a numerical dynamical model are almost never inclusive of the information that the user at the end really wants, and that the meteorologist has to deliver as part of a service. So, you had to somehow optimize the contributions of computers and automated systems and people. And it turned out very much the case, not only the people in the Weather Service, but the people who are using the information at the end. So the whole modernization activity was a very broad spectrum.

1:07:46 And so it dealt with -- actually the emphasis in the observing program I had to confess was automating it to finding ways to use the human skill elsewhere and not on making observations. Then the idea was to find ways to transform the information that was directly obtained from observations into a form that it could be used in -- in numerical dynamical models of the atmosphere ocean system. And that came to be called assimilation and sometimes a general term of analysis applied to those increasingly digital information that was coming from these automated observations.

1:08:59 Then the models themselves were sort of based on the classical equations of motion toward a kind of Newton's equation sort of things. And what comes out of them are the variables in those equations, which are not necessarily exactly what is needed for a service. Of course pressure,

temperature, and humidity are valuable. But not as valuable as things like is there gonna be a thunderstorm? Is it gonna rain? Is there gonna be a tornado? How much rain is there gonna be, and stuff like that? Which in especially in this stage in those days were not well handled by numerical models, and in fact were not well handled by most any kind of fully objective technique. But required the experience of the forecasters to, from the information available from numerical forecast models which became more and more including the analysis part of the forecast part -- it became more and more the provider of the observational information. The interpretation of those outputs was based on experience a whole lot of the time. And so we had to preserve that because the end goal of the Weather Service is to serve the users not to serve the models.

1:10:57 So although sometimes the forecasters of the days used to consider us developers ones who were not interested in what they were doing. But you know, we wanted them to serve the models rather than vice versa. So there was a kind of a mutual accommodation that was developed over the time. But as the models and the science got better, and as the work force became more educated and understood these things better; there came to be a more -- more and more optimal division of effort between what was done by computers, and by automated systems, and devices, and remote sensing tools, and things like that and what was done by humans.

1:11:52 Now this process was taken a long ways during my career. And I was quite pleased and proud of what we had accomplished -- a team of us who worked on this for a decade or so or more. But it certainly wasn't finished by any means. And I have tried to follow a little bit of what has happened. But uh, I think it's still a lot of art in -- in using technology, and computing analysis, and using experience, and understanding of applications. It's a little trickier even than the analysis models to get computer programs to understand applications. There's been a big improvement especially during the time since I've been retired in that area, and a lot of research on it which is still going on. But the applications are so diverse. And in general the applications are used by people who do not understand the science and technology of either observing or numerical forecasting of whatever -- either dynamical forecasting or statistical forecasting. When I left, the statistical approach was still very critical. And in my office of system development, I always gave it a -- a high priority as being one of the very important links between the service end of the Weather Service, and the technological and modeling part. I suspect that's still due to a large degree -- I don't know for sure.

[Pause in recording]

1:14:22 Doug Sargeant: When I first met Denny Waltz and Sandy McDonald, they were working in the field operations of the National Weather Service. And eventually uh, I hired them both into the office of systems development in the Weather Service. And rather quickly moved Sandy to his position in Boulder associated with -- assigned to work with ERL, in development. Now you may or may not know maybe a bit of background. See, well I guess I said some of it already. I sort of cut my teeth in the research side.

Doug Sargeant: And, so I was involved with ERL from the research side way, way before I was ever involved with the Weather Service. And so I had a fair understanding of how that system worked. And how important it was to get information from people who understood operations and services applied to the development and conduct of the programs in ERL. And so we made a very deliberate effort to get involved in ERL from the Weather Service perspective. And when I was in Weather Service and had come into some development, I was making a very strong push all the time to get the Weather Service involved in dealing with and understanding the things that ERL was doing. This is not a simple marriage because the operational people are so constantly involved in doing their -- their service delivery job.

1:16:57 Doug Sargeant: And even though there are many people in the Weather Service field operation who are outstanding researchers, and even have been outstanding researchers; there are limitations on their time, and their orientation. And of course during the period even while I was working on this, and more subsequently the standard of education of the field meteorologist has come up and up and up. And so they're much more knowledgeable and can interact with the output of the research schemes.

Barry Reichenbaugh: Right.

1:17:43 Doug Sargeant: I have to say, it's at least as hard to get research meteorologists to understand and be interested in operational problems as it is the other -- other way. But by and large, the people in the old ERL, they had any interest in operations. And they did want to learn about and try to help and make contributions too. And so it was always good to do those, marriages. And so Denny Waltz actually was assigned from my office to be in ERL to work with the development activity, which was then in Sandy's office who had also originally moved from my office. So part of the strategy was to build that -- build that knowledge and expertise about the users into a high enough level in the ERL labs that it would impact the design of their programs and interests.

1:19:18 Carl Bullock is another outstanding example of somebody with real operational experience, who got engaged in the development. And I have found that to be critical is to have people on both sides of this divide who are interested in and knowledgeable about both operations and development. So I knew relatively little. I thought I knew a lot more because of my working with people in the Weather Service for so many years before I came to the Weather Service. But, you know there's a lot to learn about operations. They're different.

Barry Reichenbaugh: Sure.

Doug Sargeant: And a different, a different set of constraints...

1:20:23 Barry Reichenbaugh: that's one of the things -- if I could interrupt for a second. And that's one of the things I think that also was at least a result of the modernization, was co-locating some of the forecast offices uh, with universities. And at least in Norman, co-locating the research

element with the operational element, uh the forecast office, and such.

1:20:48 Doug Sargeant: Yeah. That was another one of my babies. It was getting that established to try to have a real understanding -- a mutual understanding, by the people who were developing things with the people who are needing the results of the development. It's -- I don't know how it is now. Even then when I think things were much better than they are now with what I hear about the Weather Service, the -- the willingness to get in somebody else's shoes, and to actually devote time and resources to what have been somebody else's problems; it was a tough road.

Barry Reichenbaugh: Yeah.

Doug Sargeant: And it results in some confusion and mixed management change -- which isn't bad from a classic organizational bureaucratic standpoint. So generally it's fought at higher levels because it confuses the line of -- of management and the chain of command. And it's confusing who's calling the shots. And, as far as I know in my own belief, it was not my desire, or Dick Hallgren's desire, Bill Bonner's desire, Sandy's or Denny Walts, or what have you to get control of things -- or you know, mess around with somebody else's prerogatives. But merely to achieve a real intellectual understanding of these, what I consider to be shared aspects of NOAA's mission -- or the government's mission or whatever level you put it at. And you know lots of these people. And so you're aware that to a person the ones that we have been talking about are people who really have an intellectual interest both in research and in operations. And it's not an artificial thing. They have a responsibility in one area or the other. But they really are interested in and understand and care about the other thing. And that makes a heck of a lot of difference. And when we restructured the Weather Service, one of the ideas that Hallgren and I and Bonner pushed relentlessly was this idea of having a research-oriented scientist in the field office. And of having you know, that orientation there. So there was a position dedicated to that in every one of the WFOs.

Barry Reichenbaugh: The science and operations officer? The SOO, right. Yeah, I'm glad you touched on that. I was gonna ask you about that.

1:24:45 Doug Sargeant: That -- that was -- that was a key actually to our strategy of being able to feed the evolving science and technology into the office. Because there was somebody who had the time, the interest, and the skill to draw from what was coming out of the uh, research and development community. Or both in ERL where it was more fundamental, and in the office systems development where it was more directed toward the Weather Service mission. Uh, somebody who would relate to that stuff and take what that office needed and help get it. They understood well how that office worked, what the people do, what they cared about, what they could use and so on. And bring it in. And so the whole thing in a way is kind of a grand technology transfer scheme.

Barry Reichenbaugh: Mm-hm.

Doug Sargeant: Uh, that's -- that's really what that part is about.

Barry Reichenbaugh: Mm-hm.

Doug Sargeant: And from my standpoint, I have to confess that the -- the things that I most cared about in the restructuring part of the Weather Service were ones that would uh, facilitate getting new science and technology into the operations. It wasn't that much about the operations itself and making them more efficient or what have you. It was trying to actually get the science and operations into that stream. And so for me, that technology transfer -- science and technology transfer was the driving motivation that I was always after.

Barry Reichenbaugh: Mm-hm. And now it's a part of the organizational culture. So it's just sort of just there.

Doug Sargeant: And so that was -- that was my the way I see it, that was my motivation and my role in the modernization and restructuring of the National Weather Service. It was to develop not just science and technology that could be used for operations, but along with that to develop mechanisms that would allow it to be transferred into application. Because when I was in ERL type business as my career, as I'm an ex-academic and came out of that; it was a science and technology that I was focused on and most interested in. And it was frustrating. I encountered it from the time of GARP how decoupled the -- the development of science and technology uh, was from the operations at the Weather Service. And how little time, I may say even interest the National Weather Service had in what was out there and what was available. And to some degree, that has to be so because there has to be more conservative. And the coupling -- the coupling between the service part of the organization and the users always has to be maintained and respected. But that interface between the research and development community and the Weather Service was too strong to say non-existent. But it was sort of limited to individuals like Bill Bonner, who you know he had interest in that in the community. And uh, let's say uh, I don't want to say more right now about that.

Barry Reichenbaugh: That's okay.

Doug Sargeant: I don't -- I don't want to demean anybody. It's easy to understand.

Barry Reichenbaugh: Yeah.

Doug Sargeant: And when I went into the Weather Service, it wasn't until then. And actually I took trips to field offices and had meetings and talked with operational people. Did I really gain enough understanding uh, of how operations constrains the works to you know, be able to appreciate that?

Barry Reichenbaugh: Right.

Doug Sargeant: And so to some extent, I think this idea of cross-fertilization of organizations with people who have experienced both parts is uh, a very valuable uh, thing. And I think that that whole thing you know, when Dick Holdren left the Weather Service; and his roots were also in the research and development community. And he went to Weather Service from a job which was that

originally. Uh, that was also uh, true to a large extent of Ron McPherson. Uh, and so both of those people did a whole lot to uh, help facilitate those transfer from that sector in. Because they had one foot in both. Then both of them went to the AMS as executive director.

Barry Reichenbaugh: Mm-hm.

Doug Sargeant: And both of them carried all that knowledge and experience and orientation with them.

[Pause in recording]

Barry Reichenbaugh: I think I'd like to end and just give you the opportunity if there's something you didn't get a chance to talk about that you'd like to.

Doug Sargeant: I guess uh, one of the things that I didn't say much about except in connection with uh, GARP -- and to some extent the World Weather Watch is the uh, role of other agencies in our science and technology. And uh, this has fluctuated over time. Uh, but uh, federal institutions like NASA for example uh, and FAA, and the different parts of the Department of Defense -- especially Air Force. But to some extent Navy, especially in the modeling and uh, you know the Navy post graduate school and stuff like that. There is uh, quite a lot going on all the time in the government. And uh, one of the things that I learned in my career was it's really beneficial to have ways of uh, ensuring communication and cross-fertilization and so on across these organizations. And in particularly, uh in the development of new technologies like observing systems, and models, and so on.

There is great benefit to each of the organizations to be able to draw what's from what's accomplished in the other ones. Uh, and like NOAA those organizations have research and development arms too. And uh, a lot of the technology that is used in our science uh, has been originally developed and explored in uh, in a research part of the Department of Defense, and uh also mainly in sponsored work by the FAA. The FAA doesn't have its own laboratories and skills. And but they have historically had a lot of uh, contract work. And to the extent that that can be both learned about and influenced uh, to be of value to multiple agencies. That's really beneficial. Uh, and that I guess is one thing I didn't -- I didn't mention. But it's one thing that uh, was I found always one of the more difficult things to keep going. Uh, and I don't even know now whether the inner agency, uh mechanisms that were established -- many of them I worked very hard on myself uh, in those days have survived or not. I don't know if they're evident to you or not.

Barry Reichenbaugh: I -- I hear of meetings and you know, ongoing things. So yeah, I think they do exist. Um, I don't have familiarity with -- with um, which ones they are.

Doug Sargeant: Yeah. I think a really healthy uh, program of evolution of both the research and development activities and operational activities depends on some effective mechanisms for

keeping those things hooked together somehow.

Barry Reichenbaugh: Yeah. Yeah, well one I can name is uh, I know out of Norman with radar; they've been pursuing both the dual polarization and the uh, multi-functional phased array aspects which again are coming from the Department of Defense. And uh, they have had joint -- joint conferences and workshops on those.

Doug Sargeant: Oh that's good.

Barry Reichenbaugh: Yeah, yeah. Okay.

Doug Sargeant: I don't want to brag, but I planted many seeds for technology transfer to uh, radar using that -- to use that laboratory directly. And uh, I always kept going uh, in the Weather Services office of systems development uh, a pretty healthy involvement in radar uh, development. Uh, you know beyond NexRad.

Barry Reichenbaugh: Right.

Doug Sargeant: Including uh, the phase array stuff.

Barry Reichenbaugh: It's the same old thing. You know? They're just trying to get the budget dollars to pursue it.

Doug Sargeant: Yep. It's always -- it was always a big difficulty.

Barry Reichenbaugh: Yeah, yeah. Um, I did want to end by just asking if there are particular things. And we don't necessarily need to record this part. But let me end by thanking you, Doug. I appreciate the time you -- you spend with me here.

Doug Sargeant: Oh, you're very welcome. I'm glad someone's interested.