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An interview with

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PHILLIPS: My name is Jean Phillips. I'm from the University of Wisconsin-Madison, Space Science and Engineering Center. I'm here this afternoon with Bill Smith in Boston at the 2019 Joint Satellite Conference, and today is Wednesday, October 2, 2019. Thanks for joining me, Bill.

SMITH: Well it's a real pleasure, Jean.

PHILLIPS: So I'd like to, I guess, maybe start at the beginning since you're a Wisconsin Badger. Let's start at the beginning and talk a little bit about your early academic training, how you landed at Wisconsin, and let's just start there.

SMITH: Okay, that will be a pleasure. I got into meteorology in a strange way, and it was at a very fortunate time, you know, at the time right after Sputnik was launched into orbit. And I really didn't want to go to college. In fact, my high school counselor told my parents it would be a waste of money, that I should go to a technical school or something like that. But my dad was a very wise man and he said, “No, he needs to go to college.” And all I wanted to do was fly airplanes. That was my love and still is, actually. I still fly. I flew up here to this meeting.

PHILLIPS: Did you?

SMITH: Yes! [Laughs.] And but, in any event, he was a wise person. And so he found a college of Saint Louis University where they had flight instruction and also aeronautical engineering and so on. So he said, “I'll pay for your flying lessons if you go to this college and go into aeronautical engineering.” And so I certainly agreed to that and went down to Parks College of Aeronautical Technology. It's a college of St. Louis University. And anyway, so I went down there, and I, of course, was more interested in the flying when I started than the academics. But I got into the flight program, and as a result of that flight program, you had to learn about weather. Flying is, you know—

PHILLIPS: —very weather dependent—

SMITH: The most dangerous part of it is running into bad weather. It's the primary cause of fatal accidents in aviation. So as part of the flight training, you learned about weather. And as a result of that, I got more interested in the weather part of it than I did the flying part of it.

And Parks also had a meteorology program, besides aeronautical engineering. And there's a renowned meteorologist who ran that program by the name of Clifford Murino. I don't know if you've ever heard that name, but he was a friend of Vern Suomi's. He knew Professor Suomi. And in any event, this Parks College was a trimester program. You went all year round and had one month off per year or so. So it was three semesters a year, and you finished in three years. And Doctor Murino, who was the professor running the program—there were only about six of us in this program—and three of them, three of us, ended up at the University of Wisconsin.

PHILLIPS: So who were the other two?

SMITH: Tom Vonder Haar and Ben Bullock. I don't know if you know Ben.

PHILLIPS: I know the name, yeah.

SMITH: Yeah, and that was a result of Cliff Murino's association with Suomi. In any event, one of the most fortunate things in this program at Parks College was A, we learned a lot about weather and meteorology and the dynamics of meteorology and everything—the science of meteorology, not so much the forecasting part of it, but the science of it—and we also learned about satellites because it was right after Sputnik was up that I entered college. And the other fortunate thing about that program was that Cliff Murino had a requirement that you write a thesis as an undergraduate.

PHILLIPS: As an undergraduate—

SMITH: Yes. And that was really beneficial, as it turned out, especially for graduate school, because you had to write a thesis—

PHILLIPS: —as preparation.

SMITH: —and you knew how to do it. Right. And I wrote a thesis on the applications of weather satellites to measuring the atmospheric energetics. And I got interested in that. And of course Dr. Murino strongly encouraged me to go up to the University of Wisconsin to work with Professor Suomi, you know, applying weather satellites to atmospheric energetics.

PHILLIPS: That's where all the satellite work was being done, right?

SMITH: Yes, right. And at the time we were using radiometer measurements to try to estimate the outgoing long-wave flux of the atmosphere and things of that nature. And I figured that the best way to measure atmospheric energetics, not even thinking about the weather forecasting aspects at the time as an undergraduate, was to measure the atmospheric state—the temperature, the water vapor, and the other constituents to the atmosphere—and then once you determine the atmospheric state, you could determine the atmospheric energetics, you know, the potential energy and kinetic energy, winds, and things of that nature and so on.

So I went up to Wisconsin, and I actually was supposed to be a Suomi student. I had an assistantship under Suomi and so on. But I was also interested in atmospheric energetics. And when we went up there, Tom and Ben and myself, we all had to visit with professor Suomi and talk to him. And there was a line about a mile long out of his door of people. So I went and started walking the halls of the—it was the, not Space Science, it was the, what was the building?

PHILLIPS: It was meteorology, or the meteorology department?

SMITH: Well, it was the meteorology office, but Science Hall.

PHILLIPS: Oh, yeah, it was in Science Hall at that point.

SMITH: It was Science Hall. It’s still there. Anyways, so I started walking the hall, and that's where I ran into two other very important professors in my life. And it was Lyle Horn, who passed away at a very young age unfortunately, and Don Johnson. And these guys were working on atmospheric energetics. So I was just wandering down the hall, and I overheard what they were talking about. They were discussing some research problem. And so I just sort of peered in there, and they invited me to come in and talk, and I told them what my interests were and so on. And I was offered, after they talked to me, you know, working under Professor Horn. I don't think Don had his PhD yet. He was in his last year. And in any event, I liked Lyle a lot and decided that I would choose him as my academic professor. That was a very good thing to do because he was really wonderful at keeping me on course and getting through the graduate program.

And so I did my master's thesis on the application of satellites to atmospheric energetics. And of course, I still worked with Professor Suomi in that, but officially, Professor Horn was my professor. It was not Suomi. And I got my master's degree in a year, and then I was very tempted to leave [laughs] because I had two children already. I was married with two children. But my wife, Marcia, being a very wise woman, said, "You're not going anywhere. You're going to do what Professor Horn is advising you to do and that is to get your Ph.D. degree."

So at that time, I was working on atmospheric sounding as my way to really improve atmospheric energetics. And, of course, by that time, I realized what a tremendous impact atmospheric soundings from satellites would have on weather prediction. And so I started developing a methodology for extracting vertical soundings from weather satellite spectral radiance information. And, in any event, I was totally pretty much unaware of what was going on in Washington and elsewhere on this problem. And Professor Suomi agreed to be then my research professor, so he was my research advisor for my PhD, and I worked very closely with him on that, on my thesis and other things.

And in any event, to make a long story short, I was able to get my thesis within two years, to get my PhD. And Suomi was also in very close contact with Dave Johnson who was at that time in Washington, head of what's now NESDIS [National Environmental Satellite, Data, and Information Service] but was called NESC then, the National Environmental Satellite Center. And so Suomi said to me, he says, "Dave Wark is developing an instrument to solve this problem that you're working on, to make the measurements and so on." He says, "You should go to Washington for one year, and then come back and work with me." And so I took his advice, and, well, he, also through Dave Johnson, they knew what I was doing under Suomi on this problem, so they were very interested in having me come work with Dave Wark and others on this problem.

PHILLIPS: And the instrument that Dave Wark was developing was—?

SMITH: Dave Wark was developing the instrument called SIRS-A [Satellite Infra-Red Spectrometer] that flew on the Nimbus-3 satellite, the very first sounding instrument. And that was under development while I was, of course, at Wisconsin. And then after I went to NESDIS and worked with Dave Wark, I was working more not on the engineering, but more on the data applications and data processing—the algorithms for converting radiance data into atmospheric soundings. And, in any event, they actually hired me before I even got my degree, to make sure

I'd come there.

PHILLIPS: You know, the same thing happened to Suomi, too.

SMITH: Yeah, is that right?

PHILLIPS: He was hired before he had his degree.

SMITH: Mm-hmm [affirmative], yeah, it was very good. And so I went to Washington and started working. It was so exciting. It was very exciting because things were going so rapidly. And, of course, I had my own ideas on how the instruments should be other than the way the first one was. And thanks to the people at NESC where I was working in Washington, they got me in contact with NASA [National Aeronautics and Space Administration] headquarters, and I was able to get my own instrument programs where I was PI [Principal Investigator] and actually flew three instruments within five years on Nimbus satellites [Nimbus was a series of 7 satellites for concept and instrument demonstration and scientific experiments]. It was amazing. So needless to say, I didn't have time to come back to Wisconsin, although I wanted to. That was my real academic home, and I yearned for getting back to Madison. But I had so many opportunities, wonderful opportunities.

PHILLIPS: Well this morning in your talk you referred to the Nimbus series as sort of the test bed for so many instruments. Talk a little bit about that.

SMITH: Right. What happened was the instrument that Dave Wark was developing, and I was working with him on—on the data processing part of that instrument and the application part of it—that was on a Nimbus satellite called Nimbus-B, which was scheduled for launch on, I think it was September 18th, no, I'm sorry, May 18th, it was, of 1968. And of course, I was there for several years already, and so we were very anxious to get data from space. And I had started working with the National Meteorological Center—which is the equivalent of NCEP [National Centers for Environmental Prediction] today—on processing these data so it would be useful in weather forecast models and so on. Well, the unfortunate thing that happened, as I mentioned this morning, was that there was a launch failure. It was actually [that] the guidance system didn't work properly, and the rocket was veering off course, so they had to bring it down. It went down in the Pacific Ocean.

But the amazing part of that experience—although we were really down in the dumps. It hurt so much to have that failure. That was the first and maybe the only failure I've ever experienced with satellites, but it certainly had the biggest impact. But the amazing thing was, and it sort of conveys how people operated in those days and how the agencies operated in those days, they came right back. You know, as I said this morning, that failure was on a Saturday, and on Monday, they had the PIs gathered around a table with the Nimbus project manager seeing if prototype instruments that weren't yet qualified for space could be space qualified and put on another Nimbus satellite and flown within a year. And NASA, the NASA manager, a person that I happened to be very close to by the name of Harry Press, vowed to get this back up there within one year. He saw how disappointed we all were. And so they did. In fact, it was launched on April 13 of 1969, less than one year after that failure. And so that became then the very first sounding instrument in space.

PHILLIPS: So I want to come back to this progression, but I also want to talk a little bit about, this morning, you talked about this can-do attitude—

SMITH: Right, that was it.

PHILLIPS: —and that's part of this, getting this satellite up and launched, and making the decision to do it and getting it up there. And of course we're in a different time and satellites maybe are more complex, but this I'm sure was—

SMITH: I think for its time it was very complex.

PHILLIPS: Yes, yes. So is there different— How are things different today?

SMITH: They're very different, because in those days of course there was a lot of enthusiasm because everything was new and exciting.

PHILLIPS: You were doing it for the first time.

SMITH: Yeah, it was a different time. And we had very competent people in these programs, both on the engineering side and so on, a lot of them led by German experts who came over after the war. And so we had expert people. And, for the most part, the instrument programs, like the Nimbus program was an experimental satellite, were what we called PI-led, principal investigators. Scientists led these programs. They were the, you know, the top person. And of course scientists, when they put their reputation on the line, they don't want failure. The other thing that's different than today is these instrument programs, they were developed by a small number of people, a small number of engineers, a small number of scientists associated with them. You know, it was not bureaucratic at all. I had an instrument that was developed literally in the garage.

PHILLIPS: You had a mentor who did that. I mean, Suomi himself did the same thing.

SMITH: Yeah, exactly. Yeah. And so we didn't have the bureaucracy. We didn't have all the paperwork. There wasn't this attitude that we had to check and double-check and test and double-test and triple-test and everything before we would accept an instrument for flight. That takes a lot of people, it takes a lot of time, and the people cost money. That's the most expensive part of a flight program, the people who are employed. And in those days, we had few people, but they were all good people, and things could be done very rapidly—I mean, within, you know, a major satellite experiment such as the HIRS [High resolution Infrared Radiation Sounder] instrument, which flew on Nimbus-6. And then that was launched in 1975, and that became the operational instrument on all the TIROS-N [Television and Infra-Red Observation Satellite - N] satellites and everything and is still in orbit today. It's being now retired as a result of the JPSS [Joint Polar Satellite System] and other hyperspectral instruments, but you, know, that's been in orbit for far too long. But that was done with very few people and in a very short amount of time. The total program from proposal to being in space was, like, four years. That just can't happen today.

PHILLIPS: Now you have a decade or more.

SMITH: Yeah. Oh yeah, if we're lucky. Yeah, so there's a huge difference. And you can see this happening again in China. They're at the stage where we were in those early days of the Nimbus program and so on where they're willing to design, engineer, and put in space, and learn by doing it, not so much by, you know, over-testing, over-documenting, over- all these other things. They don't have—as we didn't then because we were dealing with experimental satellites and so on—there was not a demand for perfection. I mean, of course, every PI with an instrument wanted to make sure his instrument—

PHILLIPS: —it worked.

SMITH: —was successful and worked, and ensured that it did. And there were very few failures as a result of that. Things were done quickly, and I still think it's a good way. And it's cheaper, actually, to fly more instruments and learn from doing it, rather than, you know, paper study something.

PHILLIPS: Is the CubeSat [a miniature satellite made of cubical units, used for carrying small payloads], SmallSat [satellite under 180 kilograms] going to sort of, maybe fit in that model a little bit, or not so much?

SMITH: That's the attempt: make it small, simple, and cheap, and so on. But my fear is that the bureaucracy will still interfere, you know. But we'll see. There is no reason, though, why major satellite systems cannot be done at far lower costs and much faster than they are today. There really isn't, in my view.

PHILLIPS: Okay. So let's now go back to: you're working on Nimbus. You're in Washington D.C.. You've been there for a number of years, yes?

SMITH: Yeah, right. Well, the first thing I did was, after the SIRS and the IRIS [InfraRed Interferometer Spectrometer] instruments went up on Nimbus-3 and they had scanning versions of them go up on Nimbus-4, and I was of course very close to the data, I was processing—myself and my colleague or cohort, Hal Woolf, who you know very well. We were doing most of that on a large scale. Other people were doing research with the data, but we were the ones— Hal was actually from NMC [National Meteorological Center]. He was employed by them, so he was on that end of it. He was a very good programmer, which, you know I programmed, but I wasn't like Hal. And so we were a great team.

And in any event, the first thing we noticed in the data—what became apparent—was that the field of view, the footprint of these instruments, was far too big. It was like 150 miles on a side, a big area, and that was done so you could get a lot of energy, and high signal-to-noise, which is what you need for atmospheric sounding extraction. However, with such a large footprint, you almost always had clouds within the field of view. It was rare that you'd get cloudless information. And, of course, clouds interfere with the radiation, they decrease the signal. And they're very difficult to cope with in extracting atmospheric soundings because clouds confuse the signal.

PHILLIPS: And you don't know which is which.

SMITH: Right. From a radiation point of view, clouds attenuate the radiance. So it makes you think the atmosphere is colder than it is because it's lower radiation-to-space. So you have to unscramble— Suomi used to say you "unscramble the egg." You've got to separate the clouds from the atmospheric signal you're after. And so I did that by designing an instrument that had very high resolution, 15 miles rather than 150 miles, and had the detector array. We actually were getting data for smaller areas, but over a large distance by using multiple detectors rather than, you know, just—

PHILLIPS: Rather than a single detector for— [a larger area].

SMITH: We would use separate detectors for the wavelength. So, well, we'd scan actually the first ones in the spectral domain but over small areas, and move that area from one side to the other. So we could get fairly dense measurements at high spatial resolution. And you had to give up something, and we gave up spectral resolution to do that. So we went from spectrometers to filter radiometers to be able to get the higher spatial resolution. That helped a lot in getting a sufficient number of clearer data that made it very useful for weather prediction. And then on the first one I flew—that was on Nimbus-5 in 1972—it was successful, but we wanted more complete coverage, and so designed another instrument that, instead of having separate detectors with filters on them, used a filter wheel on the instrument. And that was called the HIRS instrument.

And we had a big experiment that Suomi was involved in—of course he was a leader in it—which was the Global Weather Experiment that was coming up at the end of the '70s, '79 and '80. And we wanted to have satellite soundings globally over as much area as we could because the objective and thinking, of course, was to try to extend the range of forecasts to seven to ten days. And so it totally depended on having high-quality sounding information going into the models to do that. And so HIRS plus a microwave instrument from MIT [Massachusetts Institute of Technology]—led by Dave Staelin, who has unfortunately passed away at too young of an age—but that, together with instruments from Oxford University that measured the upper atmosphere, the stratosphere—which our instruments were more devoted to the troposphere, where all the weather is, and not the upper atmosphere, but to extend the range of forecasting and so on you need to also measure the upper atmosphere. So these instruments became important.

Even when we flew Nimbus-5 and then again with Nimbus-6 and with the operational satellites for the TIROS-N and the NOAA—it was called the NOAA-A satellite that flew during the global GARP [Global Atmospheric Research Program] experiment—we had all three instruments on that satellite. And I was able to lead a processing system with the PIs of those other instruments—so it was Dave Staelin of MIT, John Houghton of Oxford University—where we would process all three instruments as a system and provide soundings from all the data.

PHILLIPS: So, [you would] process them discreetly, but then—

SMITH: Well, we actually put them together in the processing.

PHILLIPS: Okay.

SMITH: For example, the microwave would help us deal with clouds. With the infrared, higher-resolution instruments, we could check to make sure that our cloud-free or de-clouded measurements, you know, were consistent with the microwave measurements because the microwave is not sensitive to non-precipitating clouds. So it was very important that they be processed in synergism. And also, the final soundings were derived from a combination of the radiometric data from all three instruments. It wasn't just piecing the products from the three instruments together. It was actually using it as a system.

PHILLIPS: Okay. And so this is, we're into mid-1970s here, or late 1970s?

SMITH: Yeah. I should interject another thing, too. Of course, Suomi's influence was still tremendous with me on other things.

Phillips: Yes.

SMITH: So, the Earth radiation budget. So I was able to PI an Earth radiation budget system, which flew on Nimbus-6 also with the HIRS. And, of course, that set the stage for all the ERBE [Earth Radiation Budget Experiment] instruments and the CERES [Clouds and the Earth's Radiant Energy System] instruments and so on that are flying today. And so it wasn't just sounding that I worked on. I worked on how this started in the first place with Suomi's Earth radiation budget instrument.

PHILLIPS: And during this time, Suomi was having conversations with Dave Johnson, and they were talking about the idea of bringing federal scientists to work with university researchers.

SMITH: Yeah, that's right.

PHILLIPS: So this is also happening at this time, right?

SMITH: Yes, and it was all during— I kept in very close contact with Suomi, during these Nimbus days. You know, we would talk a lot, and we got together a lot, and so on. And in 1970 about, or '71, he said, "Well, why can't we put these instruments on geostationary satellites and get high frequency data, and do something that'll improve severe weather prediction and so on?" So he actually had that idea in '71, to take it to GEO, and, of course, that started a program that we both worked on. I worked with him on designing the instrument that could do that spectrally because that was my expertise, in that area. And he and his engineers at Space Science, like Larry Sromovsky and so on, were dealing with the hardware side of it. And Suomi was, you know, he was the PI of then the first geostationary instrument, called VAS [Visible-Infrared Spin Scan Radiometer Atmospheric Sounder]. And he was working— of course, his work was in Madison. I had a group in Washington that was working on the data processing system for VAS. And Suomi had the idea, he said, "Well this is silly, you know, us being separated." He said, "Bill, it's time to come back." And I agreed with him. I was motivated to come back to Madison, you know, ever since I had left it because that was my academic and professional home, really. And also my children were getting to high school age at that time, and Washington wasn't the greatest area—there were a lot of problems like with drugs and things like that—so I was sort of anxious to get in a better environment for my kids. You know, I have eight children, so I had quite a few of them to think about.

And so in any event, Suomi, being so close to Dave Johnson, was able to convince him that it would be a good idea for his group that I was leading for this geostationary satellite sounder, which was called VAS, which as you know that was going to fly and be launched in 1980, that we get ready for that together. So that was a wonderful thing. And so I think we were really—when I brought a small group from my team in Washington to Madison to work with the Space Science and Engineering Center, it was a federal group. Suomi in his wisdom, you know, he said, "Here all you guys have, you know, sold your homes, come to Madison and so on. What insurance do you have that you won't be pulled back to Washington?" And so he said, "We need to set up something formal." Dave Johnson had a tremendous amount of respect for Suomi.

PHILLIPS: I think it was reciprocated.

SMITH: Oh, absolutely, yeah. But to give you an example, and maybe I shouldn't say this on here, but Suomi would submit proposals to get funding from the government for the work we'd done at Space Science, and, as often exists with scientists and so on, there's competition and criticism and so on. And I remember because I was part of a review of one proposal, there was a scientist who I won't name [inaudible], but he was very negative. And we had a meeting Dave Johnson was at to decide on what proposals get funded and so on, and he was criticizing this proposal. And he said, "I don't think we should fund this thing." And Dave Johnson said, "That proposal will be funded. I don't care what the proposal is. Vern Suomi delivers. We depend greatly on him, and it will be funded." He had a tremendous amount of respect, as, of course, he should have, for Professor Suomi and all the great things that he led for the government space program.

PHILLIPS: So I want to come back and talk about the VAS program a little bit, but before we do that: this relationship between the federal research group and university scientists was later sort of formalized as the Cooperative Institute for Meteorological Satellite Studies, of which you were the first director. And we have always talked a lot about the importance and benefit of university, government, and now industry cooperation and collaboration. Talk a little bit about that.

SMITH: Well, of course, Space Science was a very unique place because Professor Suomi, Vern Suomi, was the director of it. And Suomi's interest was really in the science and engineering to get things done and so on. So we as government employees who were guests, really, of the Space Science Center, were not treated that way at all. We were all a team. We didn't have separate quarters for our offices for government and university. We worked together. In fact, I don't think people really paid any attention to whether you were federal or you were university, what color your paycheck was or what. And that was through the tremendous atmosphere that was created by Professor Suomi. I give him full credit for that. And it rubbed off on all of us, you know. It was wonderful. People, other government employees in Washington, they'd always ask me, they said, "How did you pull that off, to get in that atmosphere?" Well, it was due to two great leaders, Dave Johnson on the government side and Vern Suomi on the university side, that made that happen. They had the foresight and so on, and of course, CIMSS [Cooperative Institute for Meteorological Satellite Studies] now is a very, very important arm of NESDIS and the federal satellite program.

PHILLIPS: Well, in large measure because you were the first director. So, I mean, you had the opportunity to sort of begin to shape the Institute and the research focuses.

SMITH: Right.

PHILLIPS: So, yeah, talk about that.

SMITH: Well, you know, one of the things that we realized, even before the VISSR [Visible-Infrared Spin Scan Radiometer] Atmospheric Sounder that we were there to develop and process data [from], was that it was not going to do what we really wanted it to do as effectively as it should. And the reason was that it was on a geostationary satellite, so it had very high time resolution, which we needed for severe weather forecasting—it was using the VISSR instrument, the optics and everything—

[Interruption.]

SMITH: —but it did not have the vertical resolution required. So if you have high space and time resolution, but you're looking at too large of a vertical depth, you won't be able to see the small-scale phenomena that are responsible for severe weather very well. And so when I came to Wisconsin, I had realized before I even stepped in the door that we needed to do something. We needed a second generation VAS that would improve that. And so my interest then turned to creating higher vertical resolution instruments. And that gave birth to what now we call the hyperspectral sounders that are flying in space. And, of course, Professor Suomi appreciated that, and he had some very capable people there, and I immediately teamed up with Larry and Hank, Hank Revercomb. And Hank really ultimately led the way on engineering this capability. He deserves a lot of credit for the instruments that we're flying on spacecraft today.

And in any event, on the research side, we were still heavily involved in sounding in two areas. One was the application of the VAS data. And one of the reasons I really wanted to bring my group to Wisconsin, besides wanting personally to get back to Madison, is that Suomi created the McIDAS [Man computer Interactive Data Access System] system. And I saw that that system could be used for sounding—not just for looking at images and making time loops of images, but to be used to both edit bad data out of the products that were being produced and also to display sounding product imagery, like water vapor and temperature and things, that you could give to a weather forecaster, and he could make sense of them. Instead of being cloud images, he was able to see where the water vapor was coming from and where it's going and how the temperature was changing and so on. So McIDAS was an extremely important and exciting development associated with VAS, with the instrument that measured the soundings.

And so that was the main scientific reason for bringing my group to Madison, was to be able to use MCIDAS in our processing system. And it really was effective. You know, at the National Severe Storm Forecast Center and the National Hurricane Center, they were able to see these data through the eyes of McIDAS, and so that was very important. And then on the other side was developing a better instrument for taking the basic measurement. And that was the hyperspectral program, which was very successful, as I said, thanks to a lot of people, but in particular, I think Hank Revercomb deserves a lot of credit for it. You know, I had a technique for doing it using an interferometer, and actually the original idea came from someone else who told me about it a year before I came to Madison—but I was off to Australia for a year to help the Australians use the satellite data that we were getting now—and his name was Tom Kyle. And I told Tom, I said, "Tom, this is very interesting." And I said, "I'm going to work on this, but it might be a year." But it stayed in my mind, and I thought a lot about it. And so when I came back to Madison, that was the first thing I did, outside of working on the VAS data processing system with my government staff, was to start working on the hyperspectral sounding concept using an interferometer, a Fourier transform spectrometer. And then, of course, we went on with Hank's help to develop—

I presented this to NASA and NOAA, the concept, and they said, "No, that's not going to work. You can't do that. You can't— Just having a lot of observations at high spectral resolution is not going to give us higher vertical resolution because each observation has very low vertical resolution." And I said, "No, it'll work." I said, "We've tested it through theoretical studies and so on." I showed them the results, and finally, I'd pestered them so much they said, "Well, you've got to prove it." And NASA and NOAA agreed to each support an aircraft instrument to demonstrate it. It was a fifty-fifty idea. Actually Dave Johnson made this happen. It wasn't him, it was other naysayers [who opposed the concept].

PHILLIPS: So this aircraft instrument was the HIS.

SMITH: It was the HIS, the High-resolution Interferometer Sounder. Yeah, HIS. And that did demonstrate that we could get high vertical-resolution soundings from, you know, from space because it flew on the NASA ER-2 [Earth Resources-2 Aircraft], which flies at 20 kilometers, which is almost in space. And so then, of course, our idea, our real objective, was to get this on a geostationary satellite to replace the VAS, the VISSR atmospheric sounder. And we worked hard. We had many proposals on how to do that. We even built engineering instruments to demonstrate that they would work on the ground, you know, for space and so on. But unfortunately, in the geostationary program, NESDIS was, they were going from a spinning satellite to a three-axis stabilized satellite. And this hyperspectral concept did require a three-axis platform. We had to have that stare time in order to get the high precision needed to get the high vertical resolution measurements.

And we had an instrument that was supposed to fly on the first three-axis stabilized satellite, but this was after Dave Johnson. His successor unfortunately got cold feet and said, "We can't have two new things at the same time." And they were having problems with the three-axis stabilization system, so he discontinued the effort to put this on a geostationary satellite. But we kept pursuing it, and decided we would see if we could get it on a polar satellite. It might be easier, first. That's when we came up with the concept of CrIS [Cross-track Infrared Sounder], actually, that's flying on the JPSS satellites—

PHILLIPS: —today.

SMITH: Today, yeah. And CrIS was designed to replace the HIRS instrument, this filter wheel instrument that we flew in 1975 for the first time. And it was not intended for a new spacecraft or a bigger spacecraft or anything like that, it was supposed to just— We created an instrument that was small enough, and we worked on the data system enough so that it wouldn't have too much higher bandwidth. The data could be transmitted from these NOAA satellites that were carrying the HIRS instrument, but that never got on those NOAA satellites. When NPOESS [The National Polar-orbiting Operational Environmental Satellite System], which was the big space platform system program, was created, they looked at it and adopted it for NPOESS, which eventually then became the JPSS system. That's the CrIS instrument. And anyway, it's been an exciting program. They're out there. They're even on geo now. Even the geo instrument that we worked on is now— The Chinese are flying it.

PHILLIPS: Well, let's skip to this. You're now kind of considered, you know, the father of hyperspectral sounding. It's a term we've talked about. And much of your work has centered around this mission to get this instrument on the GEO satellite. And it's been successful in other countries. Will we get there in the U.S.?

SMITH: Will we get there? I sure hope so. I'm sure we will. It's just a matter of time. We were so close, you know. We developed the GIFTS [Geosynchronous Imaging Fourier Transform Spectrometer] instrument, and the GIFTS design, and we actually built the instrument, demonstrated it on the ground. And then the administrator of Earth Science for NASA was told from the top that NASA had to go to the Moon and Mars—that was, you know, President Bush who created the Centennial Program—but he didn't give NASA any more money to do it. So they needed money. And so they took it out of the Earth Science budget, and the administrator then canceled GIFTS, so it never made it into orbit.

But the Europeans decided it was a good idea, a good design, and they did their own studies, said "This makes sense." And now, of course, they've been developing it for their METEOSAT third generation, which will fly in 2022, I think it is or so. And in the meantime, China was developing its space program, and, of course, wanted to do novel things. And even though there's risk, they're willing to take risks to just get things in orbit, to learn through doing it. So they adopted the GIFTS design, too, and built their own instrument.

PHILLIPS: So this also gets back to this idea of sharing knowledge, sharing resources.

SMITH: Oh it's so important, yeah. The worst thing is for politics and government to create an atmosphere where you cannot cooperate. Especially in weather and satellites and so on. Satellites are generally global ventures, or most systems are. And as we know, to make the most effective use of geostationary satellites is to use the international system. It's not just one satellite to be used for one nation, we use all the satellites for a nation, and that requires international cooperation. And I've always believed that's the way it should be. And so we always shared everything with others. I had people sometimes ask me, "Why are you telling everybody your secrets and—you know—what you're going to do and [unintelligible] what you're doing?" I said, “No, I’m not worried about that because they’ll know what I know today but not what I’ll know tomorrow.” So I’ve always had that philosophy of sharing everything, not holding any secrets or anything.

And we did that with the Chinese, too, in the sense that we had a lot of Chinese students. I went over to China in 1979. I was part of one of the first delegations from the government, and I was working for NESDIS at that time. I went over with a small group of scientists right after President Nixon opened up communication. So, I went over there, did a course, and started interactions with the Chinese and their central meteorological agency.

And it was a very different China then. They had nothing. There were no cars on the road, there were only bicycles. They didn’t even have toilet facilities and showers and things in their apartments. They were all communal. Today, it’s a very modern society. Largely through—in many areas, and certainly in the satellite program, too—is by having the advantage of other nations that have been doing this: sharing their knowledge with their people. And they didn’t hide it. They flew a HIRS, this instrument that flew on Nimbus 5 that has been flying on all the satellites. And they came to see HIRS, trying to use HIRS. They were proud that they could copy something. They had been copying the [unintelligible]. And that led to progress.

PHILLIPS: Well, and another way that this has evidenced itself is you started bringing researchers from other countries to CIMSS.

SMITH: Oh absolutely, yeah. And that was certainly true after the trip to China. I had many applications for people to come over and study at the university in our department and work at Space Science and so on. And we welcomed those. It was fortunate that the University of Wisconsin at the same time was strongly collaborating with China. In fact, the university was a sister university of Nanjing.

PHILLIPS: Oh, I didn’t know that.

SMITH: Yeah, in those days. And so, we had a lot of support from the university administration for admitting Chinese students. So, a lot of my graduate students were Chinese. And, you know, we were very fortunate to have them because they were extremely hard workers and very committed to perfection and also responding as timely as they [could] to anything that needed to be done. They weren’t so [unintelligible] at that time just because of the way the culture was when they first started coming over, but as we know now that’s no longer true. They’re as creative as anyone and are doing great things.

PHILLIPS: So one area that we haven’t touched on is when you became the director of CIMSS, you were also a faculty member in the department of what was meteorology then, atmospheric and oceanic sciences now. And we haven’t talked about your teaching career at all here.

SMITH: [Laughs] Yeah, I did do teaching. It was a very important part of my profession because I enjoyed interacting with students. And I had, as you know, a lot of foreign students because, satellites being so international, I would be going to meetings all over the world and interacting with young people in those countries. And of course, the professionals, a lot of them from many,

many countries—Australia, Germany, Austria, you name it, Norway—became very close friends of mine, professional friends as well as personal friends. And those professors would send their students to work with us as well. All of the international [collaboration], through students and our visiting scientists from other countries and so on, really helped our effort in Space Science to be world-renowned. Our visitors played a very important role, along with our very competent staff, to do a lot of great things that have been done and are still being done by Space Science and CIMSS and so on.

But teaching was important. In fact, a lot of the students that I was professor of became employees of Space Science. Or they ended up in Washington [D.C.] at NESDIS or at NASA in Greenbelt [Maryland] or at NASA Langley.

PHILLIPS: There were lots of them; close to fifty of them or something like that.

SMITH: I had close to sixty graduate students. Of course, I no longer teach, but I still do advise the students. It keeps me young. [Laughs] Or it makes me think I'm still young by associating with them.

PHILLIPS: And you were the director of CIMSS for ten years?

SMITH: Twenty years. Well, I was at CIMSS for twenty years. First, I was leading it as a federal employee for a couple years, and then I took a full professorship with the Department of Meteorology, at that time, atmospheric and oceanic sciences, now. And then I became a university employee which legally allowed me to be director of the university institute. As a government employee, I couldn't lead a university organization. But practically, it didn't make any difference because the university and the government group that was there worked so closely together that nobody really knew anyways.

PHILLIPS: So, after this period of time at CIMSS and UW-Madison, you went back to federal [service]…

SMITH: Yes, well two things led me back. To be honest, when I left the federal government, this was in 1982, I think, I wasn't paid all that much in those days. And your retirement in the federal government is based on your high three. Well, my high three wasn't going to be—I left at—I was still young in 1982. I was only 40 years old, which I think is young [laughs]. And so, I left all my retirement and everything in the federal service with the idea that someday, I'll come back. So that was on one side of the issue.

The other thing was that we were working on this hyperspectral imaging spectrometer for space called GIFTS. And we were just having it indicated before, it was a hard time to get the government to accept our innovations. I figured the best way is to be on the inside rather than the outside. So, there were a couple scientists at NASA Langley who decided to retire and start a department over at Hampton University. They were very renowned atmospheric scientists in the NASA satellite program. And so, they convinced me, they gave me the opportunity. They said, "Bill, we need a new Chief of the Atmospheric Sciences Division. It's open. Would you consider applying for it? They could really use you here in our division." It was a big organization. I sort of shy away from being director to big organizations because I like to do research. And I've always been fortunate to have people working with me, like Tom Achtor did when I was director of CIMSS, to take a lot—if not most of—the administrative burden away from me so I could really direct the science and participate in the science, research, and so on. So, I made that a condition of going to NASA Langley to assume the position of Chief of the Atmospheric Sciences Division.

So those two motivations got me back into government for a few years, and the University of Wisconsin graciously gave me a four year leave of absence to go there. It was a wonderful opportunity, and it gave me the chance, then, to be on the inside to propose the GIFTS experiment, which we did and which we won. GIFTS was selected to fly on the Earth Observing 3 satellite, EO3. It was supposed to be launched around 2008, I think. And we got the money. Space Science and the group I had at NASA Langley at the time together with Utah State University—which also played a very important role in GIFTS because they had already developed a prototype instrument to demonstrate the concept—and so the three of us, the three organizations, developed the GIFTS instrument and worked together. That was accepted, well let's see, about two and a half years after I started at Langley, the proposal stage and so on and so I was already two and a half years into my four years.

In any case, when it came time after we got GIFTS developed, demonstrated, and then it was cancelled, you know, I said to Marcia, my wonderful wife of many, many years—we were together for sixty years; we were grade school sweethearts—anyways I said to Marcia, "Well, we should start thinking about heading back to Madison."

And she said to me, "Bill, if you're going back to Madison, you're going without me because I can't take those winters anymore. I'm too old for those winters." [Laughs]. So, we stayed on, then, in Virginia. But I have the good fortune of still being able to work with the Space Science and Engineering Center. I love it.

PHILLIPS: So, we've almost come full circle. What's left on your to-do list?

SMITH: There are a number of things. But one, of course, from an instrument point of view, is to get this geo hyperspectral instrument, this GIFTS-like instrument, on a U.S. satellite. Asia is flying it through China. Europe is going to fly it; in a couple years they'll be in space. The WMO, World Meteorological Organization, has this concept as their vision for 2025, and now 2040 and so on to have a ring, an international system of hyperspectral sounders—

PHILLIPS: A true global observing system, right?

SMITH: Right. And so that is my highest priority is to help them any way I can to advance that goal.

And the other thing is something I'm working very hard on as well, is to make more effective use of the hyperspectral data that we have in space today for severe weather prediction. And I am doing that cooperatively with two universities: Hampton University and I also worked with the Space Science and Engineering Center putting together the polar-orbiting hyperspectral data that we read out directly at Madison and also with the help of Space Science we put in a direct broadcast system at Hampton University and so we get real-time data from the JPSS, the MetOp satellite, hyperspectral data in real time.

And of course, we have multispectral data from the ABI, the GOES-16 and GOES-17 spacecraft. They're not hyperspectral, so they don't have high vertical resolution, but they have high space and time resolution. So, we developed a system that puts those two types of data together to try to get the benefit of all of it. It's not geo hyperspectral, but it's the best we can do with what we have. And it's showing an impact on severe weather prediction. We're running models and things like that with the data that show that these data, they're not just for global, large-scale weather prediction or for global models. They're very important for regional, intense weather forecasts.

And so, it's not operational by any means. It's routine, we do it day in and day out, but the Weather Service is not using it yet. So, my objective is to be able to demonstrate this convincingly enough that they will start using these data in their operational models.

PHILLIPS: Well, conversations are happening now about the next generation of geostationary satellites. How are you feeling about those?

SMITH: Well, it's good. There will be opportunities, again, to re-propose concepts and so on. But I still fear that going too slow because of the bureaucracy of these programs that they're immersed in. And maybe there are other ways to be able to do it faster, like commercial a route. But the government has to still support that. Companies need to make money. That's what drives them. They can do it fast because they don't want to spend any more money than necessary to keep their profit margin up as high as possible. That's why they work with small staff and do things quickly because, as I said before, time is money.

So, in my view, that's probably the best way to be able to get these new programs in space quickly. I think it will be true of the SmallSats and it could be true with the geostationary satellites for the future as well. We'll see.

But in the meantime, we're optimistic in the sense that the government is now requesting proposals and concept studies and so on for the next generation of geo that you just mentioned. And we're going to participate in those for sure.

PHILLIPS: So, one last question: as you look into the future, and you're thinking about global environmental and other challenges and issues, what's most pressing?

SMITH: You mean as far as the—well, I still feel geo hyperspectral.

PHILLIPS: In terms of the environmental problems that we need to solve.

SMITH: Oh! In terms of the problems we need to solve. Well, the climate issue, of course, is *extremely* important because we're all at risk; our children especially are at risk. And we need to be able to— And here, again, satellites are the most effective way to be able to absolutely define what changes are occurring. We see this with our imagery now, the melting of the ice caps and the Greenland ice cap, things of that nature, the opening of the Arctic Ocean. The imagery has been very important from a quantitative point of view to see what we're doing to our atmosphere. It's the quantitative measurements and hyperspectral instruments that can do that and give our politicians the information they need to do the right thing, to deal with climate change. We need to prepare for it. There is no question about the climate changing, the warming occurring. The only arguments are what's causing it. But we still have to deal with it. We all [unintelligible] that our carbon emissions are contributing greatly to it but not all politicians agree with that because it conflicts with other monetary interests and so on. But data and very convincing information will help [unintelligible] with that problem. But we've got to move very quickly on that, too.

PHILLIPS: That's been sort of the theme of this meeting throughout.

SMITH: Yeah.

PHILLIPS: Is there anything else that we didn't touch on that you would like to share or…?

SMITH: Just from a personal point of view, I just feel so fortunate to have lived during this period of time. I've had the support of many great people like Verner Suomi, Dave Johnson, and others that made my career possible. I've never felt like I was working. It was fun, always fun and exciting. And that's why I still work today; I'm 77 years old. I'm not going to give it up [laughs]. It's just too much fun.

PHILLIPS: Well, I have to say when you were giving your talk this afternoon, your excitement about the story you were telling was palpable. And [it's] very clear that those were exciting times and still are exciting times.

SMITH: Yes, right, they still are.

PHILLIPS: Well, thank you very much.

SMITH: Okay, Jean, thank you for the interview.

[END OF INTERVIEW.]

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