NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
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IN PARTNERSHIP WITH NOAA HERITAGE AND THE NATIONAL WEATHER SERVICE

AN INTERVIEW WITH TIM J. SCHMIT
FOR THE
NOAA 50th ORAL HISTORY PROJECT

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Molly Graham: This is an oral history interview with Tim Schmit for the NOAA 50th Anniversary Oral History Project. The interview is taking place on October 27, 2019, in Madison, Wisconsin. The interviewer is Molly Graham. We'll start at the beginning. Could you say when and where you were born?

Tim Schmit: Okay. I'm Tim Schmit. I was born in St. Louis Park, Minnesota, in 1962.

MG: I was curious about your family history and how they settled in that area.

TS: My father grew up in Stearns County; it's near St. Cloud, Minnesota. My grandfather worked as a granite cutter for years. If you've ever heard of Coldspring granite, that's Cold Spring, Minnesota. Then my father went to school near St. Cloud, but ended up first in St. Paul, and then in the Twin Cities working for Honeywell doing research.

MG: Can you describe your hometown?

TS: So I like to say I'm a first-ring suburb kind of guy. I went to the Hopkins School District, but we actually lived in Minnetonka, but they're both basically first-ring suburbs outside of the Twin Cities. I have nothing to compare it to, of course, but it was a good upbringing and school, going to the public schools.

MG: What did your parents do for a living?

TS: My dad was a research material scientist. He actually worked for Honeywell. Ironically, he worked in growing crystals that are used in infrared detection. Fast forward, some of those same type materials – mercury cadmium telluride, [HgCdTe] – we have on the GOES satellites today. We've got six kids. I'm a twin, identical twin. So my mom was a school teacher, did this, and this. She was a lot of things until the twins. So in our family, there was "before was twins." My siblings would talk about the dog or cat we had. "We had a dog or cat?" "Well, that was before the twins."

MG: Were you both a handful?

TS: Yes. So at some point, my mom had five kids under five. [laughter] I think we can say yes. In the basement, there was a pantry, and it used to not have a door on it. Well, until the twins.

MG: The three NESDIS [National Environmental Satellite, Data, and Information Service] guys I've interviewed so far have all had fathers who worked as scientists or in similar fields. I was curious what about your father's work or experience he shared with you.

TS: I remember growing up, at the kitchen table, I thought this was just normal, that everybody's dad talked about electron carrier concentrations and how to grow crystals and substrates and carrier concentrations. I remember the concept of if you look at, say, a parking lot in the visible and it's all smoky, you don't see anything; you just see the smoke. But if you look at it in the infrared, my dad would explain how you can see maybe one part of an engine of a car would be hot. Well, that must mean it must have just got here. Or maybe there's a part of the parking lot – there was a strange cooler rectangle. Well, that must have been where a vehicle used to be. This whole concept of remote sensing, I was always intrigued in as a kid.

MG: Does that have anything to do with your seventh-grade school experience?

TS: Yes. Seventh grade at Hopkins West Junior High School is when we did one of these career fair activities. So I took an aptitude test, where you filled in the bubbles on the sheet of paper that then get sent away, [and] come back. Meteorologist was one of the jobs that the aptitude test pointed towards. Then we studied in the library to look at different schools. Minnesota didn't have a meteorology department; Madison, Wisconsin did. I researched a little bit more. So in seventh grade, I thought I should get a master's degree in meteorology from the University of Wisconsin, Madison. Fast-forward, I have a master's degree in meteorology from the University of Wisconsin, Madison.

MG: But you started your undergraduate education at Saint John's University.

TS: Yes. So my dad actually went to Saint John's. In our family, that was the default school where you would go. I don't even remember any discussion about going anywhere else. So I went to school for two years at Saint John's, a small, liberal [arts] college, where, by the second year, there were nine people in my physics class. The whole concept of a teaching assistant was totally foreign to me. I was able to take my calculus, physics, chemistry [classes] in that small [school]. I was there for two years and then transferred to here, to the University of Wisconsin, Madison, which is not a small school. [laughter] It was good because I got to see both types of schooling. I think starting out at small schools were really advantageous. At least in those days, there were problems for freshmen to start in their intro calc. [calculus] and psychics classes. So you could come here and pay your tuition, but not get in the class. Why didn't you get in the class? Well, because the seniors and other people were registering first. Subsequently, they're doing a much better job of – "Well, maybe we should have more offerings of these classes because they're where they start." I know for a while, I was giving tours to prospective students when I was a graduate student in the meteorology department. I would say, "This is a great place. You really should graduate here, but you may want to consider going somewhere else for two years and then transferring in." Well, after a while, they stopped having me talk to prospective students.

MG: You came here specifically for the meteorology program.

TS: Yes, the program in meteorology. Again, my interest was meteorology and remote sensing. That was a real key strength of the department here.

MG: Who were the professors you had?

TS: Lyle Horn was the professor who was the undergrad representative. He was the first person that I met, and a guy that would just – so, large class, first day, he would write his home phone number on the board, and say, "Call me whenever you need to. Try to make it before eleven PM. Well, unless it's the night before an exam. Then I understand that things [happen]." But this was just the type of guy that Dr. Horn was. It wasn't just unique to our class, our situation. He was the first professor that I met when I came to school here.

MG: Did you have the opportunity to work with Professor Verner Suomi as well?

TS: I did not work with Professor Suomi. I knew him. He was around. As a student, I didn't work with him. I had a deal that Dr. Young was my major professor for my master's, but then I worked with Dr. Dave Martin. He was my research advisor, if you will, looking at a moisture budget over the Arabian Sea. I like to explain to people that my entire career is in this one building here in Madison, Wisconsin. I transferred in as an undergrad. I got my undergraduate degree in 1985, and then, continued on for my master's degree, again, working with satellites, and working then with CIMSS, the Cooperative Institute for Meteorological Satellite Studies, as a project assistantship. Then, in 1987, right after – so I graduated on the weekend, and then the next Monday, I started working for CIMSS as a researcher or an assistant researcher. I forget the exact titles; there were a couple of them. That was during the day where, okay, it's 1987, and this next generation GOES, Geostationary Operational Environmental Satellite – to help confuse people we give them letters when they're on the ground but numbers when they get to geostationary orbit. So this was the GOES-I, also colloquially called GOES Next. So GOES-I, which ultimately was going to become GOES-8. Here it was 1987. They hired me to get ready because this thing was going to launch in 1988. Well, it turns out that the launch was delayed for a number of reasons. It launched actually in 1994. But we were able to take time to get ready for that, simulating the data, getting people prepared for this next generation that had improved characteristics. So, of course, we were using previous satellites to help simulate that. For example, GOES-7, which was the previous generation. So using GOES-7 and getting ready for GOES-I, which would become GOES-8 and that whole series. That's one of the most exciting parts of my job is when we first launch this new satellite. Of course, it doesn't go directly into operations. We need to do this post-launch checkout, make sure that the images look like they should, the signal-to-noise is as specified, and put it through its paces. The post-launch test sometimes lasts on the order of six months to a year. That's before the data is going to go to the National Weather Service or others, operationally. We just have to make sure that it works and characterize it and write that up. So I've been able to do that for GOES-8, 9, 10, 11, 12, 13, 14, 15. Then we'll get to, at some point, the next next-generation, the GOES-R time. But when I worked for CIMSS, I was able to work with people like Bill Smith. In the late '70s, there was a federal group of NOAA [National Oceanic and Atmospheric Administration] that came to Wisconsin here. This was really part of this original tech transfer if you will, or research to operations, to work with people like Verner Suomi and others, these pioneers in the field of satellite meteorology. For example, in the geostationary orbit, Verner Suomi was the one in 1964 – so NASA [National Aeronautics and Space Administration] was in the middle of procuring this geostationary satellite, ATS-1 [Applications Technology Satellite]. Seemingly in the middle of it, Verner Suomi writes a six-page proposal that says, "You should put a visible camera on that, so that we can take a picture of clouds." NASA says, "Okay, that seems like a good idea." Fast-forward to 1966, first geostationary images from space showing the clouds moving and looping. He had other advances later on. The ATS was an experimental satellite. So there's ATS-1. There's ATS-3, which had three spectral bands all in the visible – red, green, and blue, so that it could make color-type images. Again, 1966, color images from geo. Ironically, when Verner Suomi first wrote the proposal, he said, "Well, when we take a full disc

…” So from the geostationary perspective, almost a tenth of the way to the moon, you’re just over one spot on here. You can see that hemisphere, that half of the basketball if you will. So Verner Suomi thought, “Well, we should do that every ten minutes because weather’s changing. So ten minutes. That’s right.” Well, they started looking at the signal-to-noise ratio on this first experimental one. “Well, we’re not going to be able to do ten minutes. Let’s just do twenty minutes just for this demo one. Just show proof of concept.” Well, then there were some of the operational follow ones. “Well, we don’t know if we can quite do twenty minutes. Maybe we can do twenty-five minutes.” At some point, we were taking thirty-minute imagery. At ATS-1, first one. ATS-3, first geo color that you could loop into space. Then in 1975, that’s when GOES-A, which became GOES-1, was launched to start the whole litany of the operational satellite constellation. Of course, since they’re NOAA satellites, continuity is key. They’re not research satellites. That’s the operational – need to work. That started in the mid-‘70s. Now that went operational. So that not only had one visible band but also one infrared band, too. So infrared, basically sensing the heat of the radiating surface. That’s either the heat coming off the ocean or the land or the top of a cold cloud. Now, interesting enough, here we had visible data. That’s great. Reflected light, works wonderful during the day, less good at night when weather still happens. But I know that Verner Suomi, in 1966, even though this ATS-1 just had a visible sensor, Verner Suomi was going to a place – that’s right – in Minnesota, Honeywell, and had meetings. [He] said, “Hey, can we get infrared detectors,” because Verner Suomi wanted to have ATS-3 not just have three colors in the visible, he also wanted to put an infrared sensor on there, as well. Well, the timing didn’t work out. So there were infrared images on other experimental satellites. Then, again, GOES-1, one visible and one infrared satellite as Verner Suomi wanted to do back in the late ’60s. That’s how much ahead of his time he was.

MG: Who was in charge of the ATS satellites? This was a few years before NOAA was officially –

TS: That was a NASA program, a NASA experimental satellite. So Verner Suomi would have been the principal investigator on the Spin-Scan Cloud Camera of which that imager was called. But there are other sensors on there as well – Van Allen [radiation] belts. [James Alfred] Van Allen was a professor in Iowa, and that was one of the sensors that was actually on the earlier [satellites]. Verner Suomi was also involved with Explorer 7 and the early polar orbits in the late ’50s – for example, looking at sensors to study the heat budget of the earth that went up on Explorer 7 in October 1959. So that’s why Verner Suomi is often called the “Father of [Satellite Meteorology]” because here it was in the ’50s, where they’re measuring – hey, there’s a lot less radiation from these cold cloud tops. So, again, there was a whole – I guess the question I’m answering is why [are there] federal groups here in Madison, Wisconsin. In the late ’70s, Bill Smith had a small group that came out here to do this tech transfer, to learn from Verner Suomi and the other employees here at the Space Science and Engineering Center [SSEC], part of the graduate school at the University of Wisconsin, Madison. Again, to get that information into NOAA to get it operationalized. So, for example, you can look at a loop of satellite images, and say, “Oh, that must be clear. That must be cloudy. The wind must be going that direction. Those clouds look like they’re higher in the atmosphere than those other ones.” Great. That’s a great start. The next trick is to get a computer to figure that all out so you can automate the winds by tracking the clouds over time – where is that wind in that direction? For example, where the large areas of data void over the oceans, you can get an idea of the wind field at least at some of the heights by tracking the satellite data over time. Again, a number of these quantitative products that are more behind the scenes. For example, that cloud information might be derived – or wind information, temperature information derived and then assimilated into the numerical models to get a better state of what the atmosphere is currently doing, which then, of course, you can get a better forecast out in time. It's true that satellite observations are really the backbone of our global observing system because they see over land and over water, and they have various state parameters that they're measuring or inferring – temperature, moisture, wind, cloud, etc. So, again, that's really been the expertise of the Space Science and Engineering Center or CIMSS, Cooperative Institute for Meteorological Satellite Studies, and working with the local group from NOAA here. The group from NOAA has gone by some different names, but right now, we're the Advanced Satellite Products Branch. So that's part of the Satellite Applications and Research. So ASPB is our local group here of NESDIS employees, and that's part of STAR or Satellite Applications and Research, and that's part of NOAA's Satellite and Information Service, which is, of course, is part of NOAA, which is part of the Department of Commerce. Then that group has grown. It's smaller now than it used to be here. I think at one point it was up to eleven or twelve employees. Now we're half that size, but we like to tell people were twice as smart.

MG: Is it just NESDIS that has an office here?

TS: Yes, it's just NESDIS. NOAA Weather Service used to have a Weather Service Office here in Madison and one in Milwaukee, and then those got combined. That's in Sullivan, Wisconsin, so basically halfway between Madison and Milwaukee. In fact, I was just out there this week. They had some new employees, and it's always fun to get to the Weather Service Office. We get to tell them about satellite data, and we get to learn from them how they're using some of our data and products.

MG: When you took that career aptitude test in seventh grade, did it give you any other career options?

TS: [laughter] If it did, I don't remember. I do remember. There was a whole paragraph. They had a list of maybe twenty jobs, but the only one I really remember was meteorologist. Oh, okay. So it wasn't so much – a lot of people say, "Well, it was when I almost got struck by lightning or when I heard a thunderclap." I came in that way. Also, one summer, I had the opportunity to intern at WCCO-TV and Radio in the Twin Cities, but I think my heart was always in research when I saw A, how much makeup that they had to put on for on-air. One of the things we did was we'd read the hourly round-up of the Twin Cities weather observations, and it went over this new thing called cable. Apparently, somebody didn't have anything better to do but call in to say, "The guy on cable sounds like he has mashed potatoes in his mouth." [laughter] That's pretty tame [compared] to what people put up with nowadays, but I like to tell people that was both the beginning and the end of my broadcast career.

MG: I wanted to have you explain to me your thesis research because I don't even understand the title.

TS: Yes. So there was a big field experiment in the late ’70s to study the monsoon over India. What we had looked at was using some of the special satellite data over the Arabian Sea, which is where the moisture gets picked up to be brought into India. So we were able to put that all together and do what was called a moisture budget if you will. So you can measure some things. You have to estimate other things. But this whole idea is how much moisture is picked up over the Arabian Sea, as the winds blow over to the continent there. It was my first taste of working really with satellite data, be it these cloud drift winds to see where the wind’s going, calculating the evaporation over the ocean and parameterizing that based on wind speed and some other terms. That was, like any thesis, a good learning experience – going through writing it up and the reviewers, etc.

MG: I have in my notes that during your graduate school experience, you were doing some work at the Space Science and Engineering Center. Was that part of your research?

TS: So this building, part of it is what was then called the Meteorology Department. Now it’s called the Atmospheric and Oceanographic Sciences. There are a number of other groups in here, too. The other large group is the Space Science and Engineering Center. That’s kind of a Venn diagram, if you will, with the Cooperative Institute for Meteorological Satellite Studies. So, for example, in my first semester as a graduate student, I was working with Dave Martin of Space Science and Engineering Center. Then my last semester, I had a project assistantship with CIMSS. But there’s a lot of overlap between which one you’re in. So that was supporting various other field experiments of collecting the satellite data, bringing it in. In fact, when I worked for CIMSS, I had the opportunity to go to the Solomon Islands and Australia to support a field experiment there, looking at this warm pool north of Australia. So we really did the satellite support of where the planes should or shouldn’t go. Maybe the two most exciting times was, one, when there was a water main break – or, I don’t know if it was a main break, but water break above where our computers were. That was when we were on the Solomon Islands, a small island. That’s where Guadalcanal is. Then, one night, I went out on one of these hurricane hunter planes. So they would go out and drop what are called dropwindsondes to measure temperature and wind field, etc. Well, I’m looking at the stars out the window. Finally, we’re heading out. At some point, I’m looking and thinking to myself, “I think we turned around.” Well, then the pilot comes on, “Well, we’ve lost one of our engines, but we got three other ones,” and didn’t seem at all concerned. Anyway, that night, the mission was scrubbed.

MG: What were you doing in the plane?

TS: The plane was really – I was really just observing in the plane because, like I say, the main part there was that other people would do these dropwindsondes and collect them. So we had a number of people there, and so then they were back doing the satellite support of where we should go. So on my night off, I guess, I could say I’d get out in this – but it was cool to ride on one of those planes, and happy it wasn’t in a hurricane. I always tell people that’s why we have satellites.

MG: Was that part of your early CIMSS work?

TS: Yes, that was the early CIMSS. So I worked for CIMSS from ’87 to 1996, supporting field experiments. I didn’t travel to Brazil, but we had data – early on, it might have been NASA, National Science Foundation field experiment in Brazil, so supporting them with some satellite data there. Then, again, using current satellites in field experiments, at the same time preparing for this GOES-I, which would become GOES-8. Then GOES-8, 9, were checked out while I was a CIMSS employee. Working real close with Dr. Christopher “Kit” Hayden, who was in charge of the federal group then. Then in ’96, due to some retirements, there was an opportunity, and I was able to get hired then on the federal side, although I kept my same cubicle. So my claim to fame is I’ve been in the same cubicle since February 1988. I don’t know if that’s good or bad, but that is the way it is. The first nine years was working for CIMSS, and then subsequently working for NOAA. So again, joining that local NOAA group.

MG: [laughter] You said earlier that there were a number of delays for the GOES-8. I was curious what the reasons were.

TS: So previous to GOES-8, our geostationary satellites were spinning satellites. So, for example, the ATS-1, the ATS-3, SMS [Synchronous Meteorological Satellite], GOES-1 through GOES-7. That’s nice in one regard because the thing’s spinning, so as the instrument gets heated up by the sun, it equally gets heated up and equally dissipates to space. The bad news is if you’re trying to look at the earth and you’re on a spinning satellite, you only get a glimpse of the earth one-eighth of the time or something like that. So you really don’t get the signal-to-noise. What you really want is to stare at the earth. You want to take measurements of the earth, just stare at the earth. Well, that’s fine. But to do that, then your satellite has to go from a spinning satellite to what’s called three-axis stabilized, it [inaudible], and it just looks at the earth. Great. That’s the good news. It just looks at the earth. Well, now, when the sun comes in on the face of the instrument, that gets really hot. Then the sun goes behind the earth, and it gets cold again. Then it comes this – so there are a lot more thermal issues you have to worry about to get these detectors because these infrared detectors have to be very cold, so they’re very sensitive. So they can look at things like fires and fog and cloud top temperatures, etc. So there was a bit more of an engineering issue. Again, this is an operational satellite, so it wasn’t a – well, if it works most of the time, that’s okay, or let’s just see what happens. So there was some delay, I think, mostly because we’re going from this different type of satellite. Again, from the spinning to the three-axis. Again, I wasn’t real close on all the engineering issues there, although we did work with GOES. So those instruments were built in Fort Wayne, Indiana. So I remember more than once going down there for reviews and seeing it being built there.

MG: Yes, I was curious about what goes into these launches and how much personnel and resources it requires.

TS: Yes. Fast forward to this, GOES-R. In late 1999, so I was a federal employee, and there was the Office of Systems Development. They were thinking of, now, the next next-generation. We had the GOES-8, 9, 10, 11, 12. Then there was a clone for the next generation GOES-13, 14, 15. But we were going to have this new new new thing. So now, GOES-R. So ’99, I started working with some of the people from the Office of Systems Development [on] what should be on the satellite. So, for example, the Weather Service came with a whole list of well, we want to see volcanoes because they put up a large amount of ash, and if you run into them, then your engines can stop. Apparently, people don't like when that happens. We also want to see vegetation, and we want to see snow, and we want to see moisture or water vapor or winds change at different layers. But when I joined, what was then called the ABI, Advanced Baseline Imager, was eight spectral bands. So, for example, on the GOES-1, we had two spectral bands, one visible, one infrared. Great. On GOES-4 and 7, you had on the imagers basically three infrared bands and one visible. The GOES-8 series, and then basically GOES-8 through 15, on the imager, we had five spectral bands, one visible, four infrared. Although the infrared changed on some of those satellites. So now for ABI – so this is 1999. It's going to be launched in 2008, and then they had planned eight spectral bands. But I looked at the list and said, "Well, we're not going to get – you guys want all these things. You can't do that with just eight bands. At the minimum, we need twelve spectral bands. So we worked out through the process. It was a NOAA Observing [Systems] Council or something like that. They approved it. Yes, Twelve bands, that makes perfect sense. So I thought, "Well, that was maybe too easy. We need eighteen spectral bands." Well, they wised up a little bit, and we ended up with sixteen spectral bands. But that's also now been the international standard. There's a ring of geostationary satellites. So NOAA operates one over – they're always on the equator because you have to be on the equator as far as the orbit goes. So NOAA operates one over the Atlantic and one over the Pacific, but then other countries have them to fill this ring. But, for example, Japan's current instrument, sixteen spectral bands. Korea's new one they launched, sixteen spectral bands. There are some slightly different ones. Europe's got a consortium of countries that operate their weather satellites. Their next-generation – sixteen spectral bands. Again, some differences. So it's very nice to see it's not just that you can see some of these new things in the area that NOAA's geostationary satellite sees, but you can see it all the way around over Asia, Europe, other parts of the world. So, I guess I'll go back to – you asked how long and how many people. I once tried to figure out how many people had a hand in GOES-R. I couldn't get a number, but I think it's somewhere between eight and ten-thousand people when you talk about all the components. What has to happen is early on, we do this band selection of what needs to be on there and some of the characteristics, the signal to noise of the instrument, some other things. So you've got researchers. You've got engineers on the government side. Even though this is a NOAA satellite – well, so NOAA then has NASA procure this for us. So then you have all the expertise at NASA. Then they'll put out the requirements to industry that are then building the various components. So, of course, to build something like this imager, Advanced Baseline Imager, very complicated, specialized – like I say, looking at different parts of the spectrum, being able to take these rapid images. The instruments are then built, tested by various companies. Then in Littleton, south of Denver, Colorado is where Lockheed Martin puts them all on the spacecraft and tests them, makes sure they work together, and tests everything. Obviously, it's a harsh environment getting up into space. It's a harsh environment in space with radiation, vibrations on the launch. So then there's a whole crew, even once the satellite's built, packaged up, put it on a truck to bring it to the plane, so it can go to Cape Canaveral, so it can be put on the top of the nose cone, on top of the rocket, and everybody that did things with rockets and testing to move it out to the launch pad. I did have the opportunity to be at both the GOES-R and S launch, which was way cool. In fact, on the GOES-R launch, we did a – well, in the morning, there was a high school teacher workshop, and I got to speak at that. Then there was a scientific – some colleagues were there. Then in the evening, the night before launch, I talked to a number of broadcasters. "What's the coolest thing about GOES-R?" I'm like, "Well, it's going to see the earth more frequently and the fine resolution. We have these spectral bands.

We're going to see things we haven't seen before. But mostly, it's just right out that window." [laughter] Sure enough, because we had a nice view over there of the launch pad. That launch went off literally in the last minute of the launch window. That was exciting. Then, of course, once it's up in space, there's this check-out period. NASA, NOAA, the instrument vendors, the spacecraft vendors, all helping to make sure that it works. So then it gets handed back over to NOAA and then to operate. You have operators, people watching the calibration, etc. So I don't know how many people, but literally, it's on the order of ten-thousands of people probably had their hands doing initial work on operations. Like I say, this imager – so now we have spectral bands that we can see, for example, volcanic ash plumes better or amount of SO2 [sulfur dioxide] associated with volcanic ash. We have finer spatial resolution, so we can look at hotspots or fires better than before. We have these different scan modes where we take a full disk image, just like ATS-1, a full disc image. Originally, that was to be every fifteen minutes. Well, the rest of the world had this ten-minute – well, not the rest of the world, but at least Japan's and Korea's and the next generation Europe's going to do ten minutes full disk scans. So working with the lead engineer, said, "Doesn't that bug you?" "Yes, that bugs me." Well, there was some space in the duty cycle, and so we were able to come up with this new scan mode where now operationally, we get ten minute full disc images just like Verner Suomi wanted in 1964. So we do ten minutes full disk. Plus, we look at the continental United States every five minutes. Plus, for each satellite, we have these two, what are called mesoscale sectors. So they're a thousand by a thousand square kilometers at the subpoint. Think of covering the state of Texas. They can be moved independently of the full disk and CONUS, Continental United States, scan. So, for example, if you have a hurricane or if you have fires – just recently, with the fires in California, both of the sectors were over California. They're offset a little bit, so now they're getting thirty-second imagery. So, from space, being able to monitor – I was on the radio once, and I talked about the temperature of the fire. The interviewer says, "You don't mean to imply that you could see the temperature of the fire from space." "That's exactly what I mean to imply," unless there's too much high overcast and too thick of a cloud. But we have researchers here and operational products that try to estimate that's a fire, that's not a fire, and then estimate properties – fire rate of power, size, etc. So you see the imagery on the internet, evening news, or whatever, which is great and wonderful and a hundred times better. But it's these quantitative products where you can then monitor where the fires are, and then put that to a model. Then there's a numerical model for air quality [that] can generate the smoke forecast and invect it down. So then you can have cases – I think in Canada they'll look at these air quality models and say, "Okay, over the weekend, we have to put more doctors on because the asthma is going to go up, because that smoke that's lofting over is going to come down," because you could initialize it with those satellite observations. I always like to say there are two users of geostationary weather satellite data, or really, meteorological satellite data at all: people that use the data and know it, [and] people that use the data and don't know it. If you know it, you're looking at – again, on your phone, you see the satellite in animation. But if you get forecast about where a hurricane's going to go or what the potential for severe weather is in five days, that's looking so far upstream that it really needs satellites to do that, not over the United States, but also these polar-orbiting satellites that can look on the other side to the earth.

MG: How does that information that you're gathering from the satellites get to the doctors in Canada? How is it translated?

TS: So the satellite scans the earth, sends that data down for NOAA for processing. That's really what we call the raw data. It's voltages. It's instrument counts. That's where its calibrated, navigated, and remapped. So what that means – it really gets turned from an instrument space to physical energy units, if you will – so the eradiance, how much energy is reflecting off that cloud Or how hot, in a brightness temperature in the infrared, is that fire. So we scan the earth. We send the data down. It gets calibrated, navigated, remapped [re-sampled], and then it gets sent back up and bounced off the GOES satellite. So then that goes to anyone with receiving disks like we have on top of our building. So, for example, that will go to the TV vendors; they'll gather that. There will be research and then operational uses as well. From that imagery or those radiants, that's where some of these derived products – like, is that a fire, is that not a fire, where is it cloudy, where it's not cloudy, how much moisture, how much instability is in the atmosphere. So then that gets into the NOAA operational stream. So maybe that's an algorithm that was designed by a researcher, but then working with others got it into operations. For example, NOAA runs not only weather forecast models but also air quality models, and those are freely available on the internet. Again, if that emergency room planning person looked to see that – oh, that's where this plume of smoke – air quality's going to be poor, now we can react to that. Of course, there are uses within NOAA – the Storm Prediction Center, the National Hurricane Center, all the local forecast offices, or weather forecast offices. There are a number of other special national centers as well. There's also two main earth-viewing sensors on this GOES-16 and 17, but there's also a number of instruments that monitor space weather. In fact, four monitors that deal with space weather, including taking imagery of the sun and the UV in six spectral bands. Like I say, either you use the data, and you know it, or you use the data, and you don't know it.

MG: How long does that process take? For example, if there's a volcanic eruption and then a flight that's due to go through its path.

TS: So when I started my career, everything was you look at – someone looks at an image. There's a lot more human intervention that's still the case, but there's a lot more push now for these automated products. So again, when you say how long does it take between – so let's say there's potential severe weather over Wisconsin, and they put this one-minute sector over there, it's tens of seconds after that [inaudible] scanning, certainly less than a minute. So this really is a real-time process. There's a little bit more of a lag for these derived products of the height of the cloud, the strength of the wind, amount of atmospheric instability, how warm is the ocean, how warm is the land, but those are on the order of minutes or tens of minutes. So then that can then automatically flow out. There's a researcher here at Wisconsin that works with monitoring volcanoes, and he's got a system where it's looking at these satellite signals not just from the GOES but from these polar-orbiting satellites as well, that could see the whole globe. It's an automatic process where, I remember one time, we were in the meeting, and his phone goes off. He looks at his phone, and he goes, "I think the two of us are the only two in the world that know that this volcano just went off." It was some puff of volcano somewhere in the Pacific. So as we go forward, it's a lot more automated processing, and it's more quantitative behind the scenes. But really, the key to the geostationary is the short – used in nowcast. I mentioned I was at the Weather Service Office with a colleague this week. We looked out at Texas, where you saw the cumulus field, and you could see that in the visible. But if you look at one of the spectral bands, you could see it glaciating or turn from a water cloud to ice cloud. Well, that means it's rapidly growing. Then, subsequently, we have this geostationary lightning mapper, which gives you total lightning, also on the GOES-R or GOES-16. We can subsequently see the lightning from that storm. Again, the progression. But, again, that was as it was happening. We also looked at the 3.9 microns, that's a short-wave window. That's an infrared band, very sensitive to temperature. So we're looking at a loop over California. There's a hot spot up north of San Francisco, but while we're making the loop, another hot spot flickered there. They're like, "What just happened there?" "I think that was a fire explosion. It just started. It was cool. Then it was hot." "Well, is it really a fire?" Now we went and looked at one of the visible bands. Yes, there was the smoke plume from it. So, again, in the order of minutes, and again, in that case – often, with these mesoscales, it's just one minute cadence because you're looking at two different locations. But again, depending on how fast things change or whatever is happening, we can get one-minute imagery. Normally, we get one-minute – we get thirty-second imagery. For example, we did that with Hurricane Harvey. Even when we were checking out GOES-16, there was a very active hurricane center. So we were able to use that data and flow it to the National Weather Service. Even though it wasn't operational, it was in this checkout period. But, the data was so much better – I could say a hundred times better, more spectral bands, finer spatial resolution, and covers the earth faster. Even researchers put in a request as far as these mesoscales go, although it is the lowest priority. So obviously the operational ones are first. So when I was going to the GOES-S launch, the second in the series, I put in a request of, "Wouldn't it be cool if we could have one-minute imagery from GOES-16 over Florida because you could see the heat of that and you can see the smoke plume." So there, I'm still at launch, [and] I look down on my Twitter feed. Everybody's putting out these loops of one-minute imagery. All I have to do is say, "Like." To me, that's really been the biggest change with these satellites over the years. As I said, I helped check out GOES-8, 9, 10, 11, 12, 13, 14, 15, 16. It was a pretty small group in the world who knew that was happening, got access to the data, could share first results. Fast forward to GOES-R, which became GOES-16, now even though we weren't even operational yet, social media was putting out animations, people sharing loops, people asking about it. Again, it went from hundreds to thousands between GOES-15 and GOES-16, really, with two things – one, having social media, and two, having data that's so much better that people are excited about [it]. I think if it would have been, "Here is an image that looked like the one you had before," that's not quite as exciting. But when you can say, here's thirty [second] or one-minute imagery – I remember for years, I'd give a lot of talks to the various groups that were going to use GOES-R. So I remember talking to the Hurricane Center, and saying, "We're going to have one-minute imagery, and it's going to look at these hurricanes as it goes across. We're going to look at these mesoscale vortices within the eye, which the older resolution satellite GOES were just too blurry to see." So fast-forward, here again, it's on Twitter, everybody. There's the one minute – just as we said. Of course, I wasn't building the satellite, so I had to stick my neck out a little bit – "Oh, yeah. This is really going to be good." Words like "game-changer" and "awesome" and "beauty" [inaudible] a lot of big changes when we went from the old legacy GOES to the GOES-16.

MG: What will be the next GOES, the next generation?

TS: So we still have two more in the GOES-R series. So GOES-R and S are launched and up there and operational as our east and west satellite or sentinel if you will. There are two more to be launched, T and U, which will ultimately become GOES-18 and 19. Just recently, there was a broad agency announcement put out about hey, what are some ideas about the next generation. So nothing's been decided on that. But my whole career, these GOES satellites have evolved spectrally, putting more spectral bands on, be able to see more things, different parts of the equipment, finer spatial resolutions to be able to resolve fog lying in the valleys, fires. Again, Weather Service Office saw a hot spot on the GOES-16, called their local 9-1-1 dispatchers, "You guys have a fire west of town?" "No, we haven't heard anything, but we'll send somebody out." This is Western Kentucky. They send somebody out. A barn's on fire, seen from GOES, a tenth of the way to the moon. Anyway, my whole career, these satellites going from GOES-1 to GOES-R/GOES-16, have evolved spectrally, spatially, and temporally. I expect that to continue on the next generation. There was also an instrument called Advanced Baseline Sounder, which was slated to be on GOES-R. That gives you very fine spectral resolution to be able to resolve more vertically in the atmosphere – temperature and moisture and wind and other things. So that was on GOES-R in its planning stages, but at some point, that, in 2006, was canceled. Really just too big of a step with this new imager and this new sounder. But that's one of the targeted instruments on this next generation series. Again, we'll have the good quality imager like we have today, which gives you high temporal resolution and high spatial resolution. Hopefully, we'll get this hyperspectral IR, which will give you high vertical resolution, something that Verner Suomi said in 1985 would be very useful and feasible to do. As usual, we're trying to keep up with Verner, the vision of Verner Suomi.

MG: This seems so important as weather becomes more extreme.

TS: Yes. What we say is the satellites are really good for – well, first of all, we don't just turn the satellites on when there's extreme weather. I know some people think, "Wow, you just turn them on when there's a hurricane." No, no. We have them going all the time. But that's what the satellites give you is monitoring these extreme precipitation events, heat events, hurricanes. So, yes, in the changing world, these satellite assets are just even more important than they've been over the years.

MG: So there is twenty-four-hour surveillance to catch things like a barn fire in Kentucky. So are there NOAA employees working overnight?

TS: Oh, yes. So there are 24-by-7 people monitoring the satellite and health and safety of that. Of course, there are also people working with the data, be it National Weather Service, etc., that are operating all the time in a number of these national centers, as I mentioned – Storm Prediction Center, National Hurricane Center, etc.

MG: I was thinking about coordinating vacation days to make sure someone is –

TS: Yes, someone has to. Luckily, that's the one benefit of being a researcher. But yes, there's imagery all the time. Like we say, the weather doesn't stop, so the satellites don't either.

MG: I want to understand the spectral bands a little bit better. Does each one capture or measure something different, or is it like having a bigger piece of paper to write on?

TS: Basically, this instrument is a telescope looking towards the earth. We get radiation from the earth in a number of detectors. That radiation coming from the earth is all across the electromagnetic spectrum. During the day time, we'll have visible data or reflected. Then also day and night, we have a thermal component. Everything that has a temperature radiates with a certain frequency. When that data, when that stream of radiation hits a mirror, hits another mirror, it goes through various [inaudible] called beam splitters, and then different spectral band-passes. So you have basically information from the visible go to these detectors, and the infrared go to these detectors. Then within the visible, we have it broken up. For example, we have a blue band at 0.47 microns.

MG: Do you want to take a break?

TS: Yes. I'm going to get a drink of water.

TAPE PAUSED

MG: Okay.

TS: You'll have to remind me what we were talking about.

MG: I was going to have you remind me.

TS: [laughter]

MG: We were talking about the spectral bands.

TS: Oh, yes. The spectral bands. All right. Okay. So the satellite collects spectral band radiation from the earth. They get spectrally broken up, if you will, on the spacecraft with these beam splitters. Then you have infrared in one part and falling on their detectors. You have different band-passes, so you get just one part of the electromagnetic spectrum. For example, in the visible, you can have one that's more part of the blue part of the spectrum at 0.47 versus the red part of the spectrum. You can see, for example, these nice color images that we put together. That's because we have this blue band. If you want to look at aerosols, smoke in the atmosphere, shorter wavelengths are more sensitive. That's why you want to have some different spectral bands. We also have what are called near-IR [infrared]. You can almost think of them as near-visible bands. So 0.86 microns is also called a veggie band. So that's sensitive. That reflects differently off vegetation. For example, you have a burn scar, that's very dark in this band. You might care where a burn scar is because then if it rains heavy, there's no vegetation. If there's no vegetation, then you might get mudflow or something like that or a flash flood off this. Then in the infrared, like I say, we have things that are more what I'll call atmospheric windows. That more sees down to the surface. But then there are also bands that are sensitive to other molecules in the atmosphere. So we have one that's sensitive to CO_2 [carbon dioxide], so we can get temperature. We have one sensitive to large amounts of SO_2, so that's how you can get SO_2 if there's a volcano. You care about that because where there's SO_2, there may or may not be ash. There's what are called water vapor bands. So those are part of the electromagnetic spectrum that sometimes you won't even see the surface of the earth; you'll just see the swirls, if you will, in the mid part of the atmosphere. Again, that's a different part of the infrared electromagnetic spectrum. But then having these different spectral bands, then you can either combine them or difference them. For example, if you have one band that's sensitive to SO2 and one that's not, you can difference them, and that signal can pick out. You can either do that in an imagery sense, or you can do that in a computer derived product level two type processing. So you can get those – so that's when I say originally on GOES-1, we had the two spectral bands, we had the two spectral bands, one visible and one infrared. But then, of course, you weren't going to be able to see fires as sensitive, and you couldn't see SO2, etc. So, as I say going from the legacy GOES, or GOES-15 and before [with] one visible [and] four infrared, now we have the two visible, four near-infrared, which we didn't have any of, and ten infrared. So that's why I say this Advanced Baseline Imager is at least a hundred times better. It's at least a factor of three better with more spectral resolution or more spectral bands. It's a factor of four better spatially. So in an infrared – well, I'll say in the visible. There's ATS-1, what you could resolve – the resolving power – its resolution for the visible band was four kilometers, which was pretty cool. Nobody had ever done that before. That's four kilometers. Fast-forward to GOES-15, one kilometer; that's pretty good in the visible. This ABI, one of our visible bands, half a kilometer of what we could resolve. In the infrared, when I started my career, we had in the water vapor, fourteen kilometers. Okay, that's kind of nice. Fourteen kilometers. Well, eight kilometers on the medium GOES. We had four kilometers on GOES-15. Well, now we're at two kilometers for GOES-17. That's a factor of four even just from GOES-15. Then, as I mentioned, we can cover scan the earth. We have so many more detectors. We can cover the earth so much faster; on average, at least five times faster. So it's at least three times four times five, and then we have higher bits per pixel, and we have better calibration, and we have better instrument navigation and registration. Literally, it gets to be two orders of magnitude improved.

MG: You mentioned all of the other international satellites that are in the atmosphere – or, is that where they are?

TS: Well, they're above the atmosphere. They're basically a tenth of the way to the moon, approximately 36,000 kilometers.

MG: How are all those groups coordinating their launches and their data?

TS: So there's a group, a [Coordination] Group for Meteorological Satellites, which actually started to coordinate the geostationary ring of satellites. So, for example, Japan and Korea's imager that they're now operating was built [in] Fort Wayne, Indiana by Harris Corporation. So that's a direct way where things are. But again, this group will really just inform – "these are our plans" – but there's also WMO's, World Meteorological Organization, data format. So it's not that one group is saying you must do this. But it's more, "These are the international standards. These are what our plans are." For example, we have a band at 8.4 microns, which is good. You can see dust with it at day and night. You can infer the phase of the cloud – is it ice or water? – at night. Well, that was earlier on the geostationary satellites of Europe. So to get ready for ours, we could show these cases over Europe. So it's been a back and forth. I mentioned these water vapor bands. Europe was the first one to put water vapor bands on a geostationary satellite, and subsequently on our satellite. So there's a lot of international coordination to make sure that all that data is shared. In this building, we bring in data from all the geostationary [satellites] around the world so we can do research and learn from other ones.

MG: Can the satellites detect nuclear activity? For example, if there's a reactor disaster.

TS: They're not designed for that. It certainly would detect the hot spot, though, like I say, for something like that, you'd really want a staring instrument that gives you continuous time for ABI. Depending on where on the world, we might have five or ten minutes. Well, ten minutes could be a big difference. So never seen one from our satellites, but, for example, we have seen if a meteor is big enough in the atmosphere. We could sometimes see if the timing is just right, the hot spot associated with that, or sometimes that may cause a plume in the upper atmosphere. I know that we've seen that. The geostationary lightning mapper does basically stare. It's an optical sensor. So it'd say, "Oh, this is brighter here." Then it tries to determine what things it's not. So, okay, it was glint off this cloud or fire or something like that. But no, it's lightning. But other things that show up in our atmosphere as things that are bright and then go away are meteorites or meteors when they're interacting with the atmosphere, too. Even though that sensor was designed to see lightning, the meteor people are very interested in seeing that. There are, again, just a lot of uses of these because we're just looking at the earth-atmosphere system.

MG: Are you frustrated by flat-earthers?

TS: [laughter] My favorite tweet of all time might have been when it said, "Flat Earth Society." It said something like, "They have followers all around the globe or something like that." Somebody that I follow then said, "Just let that sink in." Well, the beauty is – well, I've got a lot of favorite satellite loops, but one of my favorite satellite loops is seeing the shadow of the great eclipse go across the United States. So it's hard to explain that if everything's flat. I guess I'll just leave it at that.

MG: How is all of this data being archived?

TS: In the early years, the national archive for the GOES was actually here in Madison, Wisconsin, in the Space Science and Engineering Center. That function has subsequently moved to – in Asheville, North Carolina is the CLASS system. So all the GOES data goes in there, along with other satellite data, freely available in these NetCDF formats. So anybody can download the data. Also, NOAA's got a big data project where, yes, it goes into this national archive CLASS, but it also goes in the Cloud, Amazon, Google, etc. So if you want to say, "Boy, I heard there was one-minute imagery over my house yesterday. I wonder what it looked like in the visible." You can go to the Cloud, download that file. I have on my webpage software that you can interact with that NetCDF if you don't have your own – been looking at your own GOES image. Of course, if you do it in time sequence, you can make a loop. The data is all freely available.

MG: How far does it date back to?

TS: Well, it's pretty constant back to '78. It was hit and miss before then. Obviously, there was data before then. As I say, GOES-1 first went operational in '75, but we've really had the idea there of well, here's the imagery, and we take, and we use it. Or if it got saved, it was saved short-term. That was before my time. But again, you can look at – and that's some of the things I do. Just recently, October, we had the anniversary of the launch of GOES-A. So, using the archive upstairs, I put out a loop of GOES-1 visible data. I think that was later in its operations.

MG: I wanted to go back over your career in just a little bit more detail. When you were with CIMSS from 1987 to 1989, I have here that you set up the VAS [VISSR Atmospheric Sounder] satellite sounder. I wasn't sure what that was.

TS: Okay. It was '87 to '96 is when I joined the NOAA group. I was involved in working with others. So this is pretty serious acronyms now. The imager on the early GOES was called the VISSR, Visible-Infrared [Spin Scan] Radiometer. Then the VAS is the VISSR Atmospheric Sounder. So that was a doubly-nested acronym. There was some other acronym that used VAS in it to become a triply nested acronym. Anyway, this was the precursor – I mentioned this Advanced Baseline Sounder, the high spectral resolution that was on the GOES-R series, and hopefully will be on the next generation. Well, that proof of concept was first done on GOES-4 and then had that on until GOES-8. In 1980, it was first on as a demonstration instrument on a NOAA satellite. But that instrument was still on GOES-6 and GOES-7. So the early part of my career, we were still using that data, doing research, understanding what we could get out of it as far as the information content. Basically, that was the follow-on – that was an experimental sounder on a geostationary orbit, which proved that yes, we need an operational one. So on GOES-I, which became GOES-8, there was the imager, which I've talked a lot about. But there was also an operational sounder that was operational that had eighteen spectral bands in the infrared. But that operational sounder came about because of this VAS demonstration project, which I was a small part of.

MG: Anything else as part of that work with CIMSS?

TS: That was being able to work with researchers like Paul Menzel and Bill Smith and Kit Hayden, really some of the big names in our field at Wisconsin. That was an exciting time. Once we got the new satellite, GOES-8 again, first image – nobody's ever seen that image before – characterize it, show it to other people. The best part of my job is when we get this data. For example, with GOES-R, they had taken some of the first data, and they sent it here to Wisconsin so we could share it with our team. We have part of our team out in Colorado as well, so we could make these first light images that would be part of the press release. So, of course, NOAA/NASA, that's great, but we made the sixteen channel image here to show the different confirmation of all the spectral bands. They looked just like we were simulating that they should look. People on a team from Colorado made a nice and natural color image that was part of the press release that went out. But we got to see that before they went out to the world.

MG: What was your title in 1996?

TS: My title then and my title now is meteorologist. I try to explain to people that I'm a research satellite meteorologist because if you start with meteorologist, that doesn't really – "Well, what TV station?" "Not on TV." A research meteorologist helps a little bit, but again, my entire career has been working with satellites, specifically the GOES satellites. So that's been my official title, although the beauty of working with the federal government and being flexible – I've worked on projects [on] all parts of geostationary satellites, from the hyperspectral to these imagers, working with colleagues here, working on some data compression. As you can imagine, the good news when you have faster coverage and more spectral bands and higher resolution, well, that's a higher data rate. Well, what about data compression? Just being able to work with CIMSS colleagues – I mentioned how when ABI was eight bands, and then we got it from eight to sixteen. I was able to do that because I could walk across the hall, and colleagues would say, "You should put this spectral band on." "Why?" "For this and this and this, collect data, get that back into NOAA." So being able just to work with researchers at CIMSS and SSEC and through other cooperative institutes of which they represent is a real good way to get information into the federal government. Even though my position has been meteorologist, I've worked on a number of satellites and other components, including working with CIMSS colleagues and others on the training. Obviously, when you go from – historically, the Weather Service before GOES-R used three spectral bands. The vis. [visible], the IR, and the water vapor. Well, now, we have two visible. Now we have these four near-IR. The ten infrared include three of the water vapor. So, being able to work with CIMSS employees and others, and working with the Weather Service and their AWIPS [Advanced Weather Interactive Processing System], being able to be very clear. Well, if you want to call them bands one through sixteen, you can do that. Their central frequency that may mean something to somebody – 0.47. But then we also gave them all nicknames – the blue band and the red band because now we have to differentiate between new visible bands. Not that those spectral bands just do those one thing, but at least gave a way to communicate with it. So we were able to work, again, with distance learning or site visits or short courses at satellite conferences or AMS [American Meteorological Society] conferences. Some focused more for broadcasters. Again, new data come to them; some more for researchers [and the] international community to get everybody up to speed to be able to not only have the data, which is the first part but actually know what data to use and when. That's where the training really comes in.

MG: You've been working on the GOES satellites longer than any other NOAA employee.

TS: Certainly, I think I've been working longer on the GOES-R satellites longer. As I mentioned, there's these thousands of people out there. So that may be a true statement. I don't know. But again, certainly on the GOES-R, partly because I started working on it in 1999. I don't remember when the program office started, but I think that was 2003, something like that. In fact, once somebody came, and they wanted to interview me about how we decide what to work on. He said, "Look, I think I understand how this works. You look at the strategic vision that's given from on high, and then you decide what to research." I said, "Well, I was working on this satellite for seven years before it went into that plan." "Oh, okay." [laughter] That's why I say I think for the GOES-R series, specifically the ABI. There are some other people – Paul Menzel's been working, too, but he's retired from the federal government. That's why I have to quantify it as still working for NOAA.

MG: You've received so many acknowledgements and awards for your work. I was curious if any stood out to you as particularly meaningful.

TS: Yes. So, first off, when the end of the space shuttle program came, I got a space shuttle patch that actually flew into space. So that was for support – "in recognition of your dedication, commitment to excellence, and your achievement in support of the space shuttle program." There's a nice letter that went with it. The patch that was in space is pretty high on the list. The Department of Commerce gives out a number of awards; I was able to get the gold medal, which is their highest one that they'll give, and that was for this work where we have these satellites. As I mentioned, they're in orbit, and they need fuel to keep pointing directly, exactly at the earth. At some point, there's a little bit too much wobble, so then they aren't operational satellites anymore. Fine. So they retire. Well, working with many others, we're able to take GOES-10 and then GOES-12 and operate that for something like five additional years, not as an operational satellite for NOAA because we had our east and west one. But, it was moved over the equator at sixty [degrees] west and operated for support of South America. So then the scans were usually of the equator and southward. We did a training exercise in Brazil for them to get to know about that imager and sounder. Instead of saying, "Well, it's not good enough for our operations, so now it becomes space junk; they're put up in a supersynchronous or graveyard orbit, which now GOES-10, 12 are now. But again, we're able to get these five years of extra lifetime. So I was able to get that gold medal award for that. I was also a finalist for "the Sammies," or the [Samuel J. Heyman] Service to America medals. That's over the entire federal government. So that's very impressive. There's a gala in Washington, D.C. They call it the Oscars of the government or something like that. So just to become a finalist – again, that was work for GOES-R, but it really represented literally the thousands and thousands of people that made this incredible thing possible. That was certainly quite a time. Again, Service to America finalist. You have to read the bios of all the people; it was really, really incredible. This is put on by a group to help highlight the work that federal government employees do. So people from NIH [National Institutes of Health] there talking about researching and working years and then the breakthrough. Now they can [cure] autoimmune diseases, they can isolate this disease and discover that, and then turn around and here's a – now they couldn't do that originally. But that work that only the government is doing or can do, [is] long-term type stuff. So that was quite an honor. Then most recently, I was awarded to become a fellow of the American Meteorological Society. They have rules that only a small fraction of a percent of theirs can become fellows, which is a little bit worrisome to me because I always thought that only old become fellows, so I had to redefine and say, "Well, I guess they give it to some young people, too."

MG: What does it mean to be a fellow?

TS: I don't quite understand the whole process, but only AMS, American Meteorological [Society], fellows can nominate other fellows, and it's a rigorous process to go through. Mostly it means when you go to the AMS meeting, you get to wear a little pin that says "AMS Fellow." [laughter] It only recently occurred, so maybe I'll have to get back to you what it really means. But what it really does is it reflects on the work I was able to do, but really the team here. Because, obviously, as we mentioned, there's building satellites, there's getting satellites to launch, there's weather support through the launches, there's operations, there's all the work that's on the research side that then gets into operations, and operations to ultimately get people to make decisions differently. If any one of those pieces weren't working, it wouldn't matter how crisp of a paper I wrote and was read in the *Bulletin of the American Meteorological Society*.

MG: Do you plan on attending the next conference? I think it's in Boston in January.

TS: Yes, I do plan. In fact, AMS, we're celebrating our hundredth anniversary. My talk that was accepted is ATS-1 and GOES-16, what has changed and what has stayed the same, all in fifteen minutes. So I have to skip – I think I have one slide on GOES-1 through 15. But obviously, the biggest step was going from zero to one satellite in this ATS world. Obviously, I think the biggest improvement has been going from the GOES-15 to the GOES-R series like I say, a hundred times better. Well, I guess the first step was a million times better, and this step is a hundred times better. So I really look forward to that, and doing some of the history, too

MG: Would they let me attend? I'm not a member.

TS: Yes, they will let anyone attend. I think that all you have to do is pay to be there. There is some history there. It's usually well-attended by NOAA employees. The AMS meeting the previous January was, sadly, during the federal government shutdown. I was to go on the government's dime, but I went on my own dime because I figured they're never going to give me an AMS fellow again. But that was very weird because I could be there for part of it, but I couldn't give my talk because that would be working for free, even though I was exempt from the furlough, so I needed to work. But yes, AMS annual meetings, there's a lot of things going on. I usually just stick to the satellite part. But there's sessions on teaching and training and all parts of meteorology.

MG: The other thing I wanted to ask you about was all your publications. I think you've written 621 papers.

TS: No, and yes. Those might be considered gray literature. So a pre-print or the referred journal articles is currently ninety-seven. I forget the number. So that's the one I stand by a little bit more. Since I worked on these next-generation satellites, part of my job was to get the word out. One way to do that is publications. Very proud – AMS has a bulletin, *Bulletin of the American Meteorological Society* [*BAMS*], and before a launch, we had written up about all the attributes of ABI. It took a little while to get published. At first, I thought that was a bad thing, but it turned out to be a good thing because then we subsequently launched and got the first images. So on the cover of a *BAMS* is the actual images of sixteen spectral bands – in their words, "sweet sixteen." I think something like eight months running that was the most read AMS article. Mostly because, again, a new thing that touches a lot of people; everybody needs to know a little something about it. It's a [inaudible] survey article.

MG: I also wanted to ask you about your media appearances. You sent me the link to the video that played during a recent Wisconsin Badgers football game.

TS: Yes. So the Big Ten Network Live came. This is this deal of a minute-long total thing – total thing, minute long. They were highlighting the history at the University of Wisconsin here with Verner Suomi, of course, Explorer 7 and '59, ATS-1. As we like to say, the legacy continues with what we're doing here. So I got interviewed for that. Of course, they said, "Now, when we ask you a question, we don't want you to talk for a minute because the whole thing long is only a minute." So we were able to put together – they did a nice job of hitting just that – some of the history for the initial satellites, these are a hundred times better and how really they affect your life. You may know it, and that's fine, but they're up there. I think one of the most interesting ones – I was selected to go on the show on The Weather Channel, *Weather Geeks*. Obviously, that is a great honor for any meteorologist. That was down in Atlanta. The way they tape it, [they] record it like it's live, but then they play it back later. So complete with, it can only be so long, and these are where the commercial breaks come in. They made sure that – "Well, we don't give you the questions ahead of time because we want to make sure that it's fresh or something like that." So then, again, trying to be clear, not too long. It just went so quick that I'd be asked a question: "Tell me about how much better the next generation is." "Well, as you know, it's better spatially, spectrally, temporally, calibration." Well, I would get maybe the first one in, "Okay, time for a break." So then I would get asked a new question, but I tried to then go and answer a little bit of the earlier question. Anyway, it was fun to do. Again, I was on a local radio station. That's when the guy asked, "You don't mean that you can see the temperature of the fire?" "Yes, I do mean you can see the temperature of the fire." I was interviewed in *Wired* magazine once. So a GOES-R launch date was pushed back; it was going to be in March of 2016 for GOES-R, and it got pushed back to the fall. I could say that, but we couldn't say exactly when because they didn't know when, or that wasn't released yet. But I got it approved with NOAA affairs that I could say it got pushed back. So the interviewer says, "I want to talk about this great thing that's going to be launched in March." "Let me stop you right there. It's not going to be in March." This hadn't really been advertised yet. Then when it came out, it looked like I was the first person saying this, including one of our colleagues in Canada. His job was to get ready for GOES-R. He said, "Well, Tim, it says you said that this is going to be in the fall. Is it true I have more months to get ready?" "Yes, that is true." That one was a little bit – they said I could say it, but again, best to let people know. For example, they were upgrading their antennas in a number of places in Canada, so they were prepared to get the GOES-16 data.

MG: What about your career with NOAA have I forgotten to ask you about, or have we left out?

TS: So we're here in Madison, Wisconsin, the main group for the satellites is in the Washington, D.C. area. There are a lot of people that I'll work with just via telecons or just talk to via email. Then, years later, I might be at a conference, or I get out to D.C. It's like, "Oh, you're John." [laughter] It's a unique [environment]. It's wonderful to be here on the university campus and working with CIMSS coworkers. But again, it's a little bit different perspective than I'm sure people have working in D.C. Although, there are often meetings. I was just recently back for a meeting on a project that we're working on. So I was able to, again, meet our STAR, Satellite Applications and Research [team, and] our new chief of staff. I had gotten emails. We'd been on telecons. I've really been fortunate to be able to work with a lot of mentors, either here in the building – Bill Smith, Paul Menzel, Dave Martin, Kit Hayden – or just working with NOAA employees either in Colorado or in the Washington, D.C. area. Again, that's the beauty of the satellite data. It's all over the world. Like I said, working with international partners as well.

MG: I forgot to ask what your twin brother ended up doing?

TS: So he's my twin brother. He also went to Saint John's University for two years. Then I transferred to a Big Ten university in Madison. He transferred to a Big Ten university in Minnesota. He was studying to become an English teacher. So at one point then, I was thinking, "Well, if I wasn't going to do the meteorology, maybe I'll be a high school science teacher." But I thought, "Well, let's do this meteorology thing first. If that doesn't work out, I could always switch over the teaching side." But I wasn't going to be able to go the other way around. So he went with English teacher and then a guidance counselor and stayed in Minnesota where we're from. I came down here to Wisconsin, Madison, and I haven't left the building in one sense, but in another sense, been able to travel all over the world. Like I say, to training in Brazil, field experiments in Solomon Island or Australia, Europe, etc.

MG: Was there anything else in your notes that you wanted to include?

TS: No, I think we got everything.

MG: Well, I wanted to ask about your life outside of work.

TS: So, two daughters. My wife and I are very blessed with that. They're now both graduates of the University of Wisconsin, Madison. So that's super good. This afternoon I play pickup soccer, once a week, as late in the season as we can. But when the snows come, and the field gets all icy, then we have to wait until the – there's also a group called "November Project." It's a fitness group that's got communities all over the United States. It was started in Boston. We do that a couple of mornings a week. I also mentioned, every day after lunch – sometimes this office can be very cold, so a colleague and I walk up – we're in a fifteen-story building. Every day after lunch, we walk up over and down to get the blood moving a little bit. My wife likes to travel, and I like to be with my wife. We travel to a lot of fun places. This summer, we did a two-week driving trip up to Banff and Jasper [Alberta, Canada]. If you get up there, that's a beautiful spot of the world. I'd read some of the things – "Oh, this highway between the two is the most beautiful highway." Well, somebody should have gotten paid extra for all the hype. But it really was just gorgeous there. A couple falls ago, we were in France with some other friends. Somehow, we rented this boat that we're going up the river. My wife and I's job was to open and close the locks as you would go in. "How did we get here?" Anyway, I seem to keep busy. There's always things going on, on campus here. I've given a number of talks. There's a weekly [series] titled "Wednesday Night at the Lab," here on campus. So I gave a couple of talks there about how good the satellite was going to be. So I was at the GOES-R launch, hadn't even got back yet, [and] I got an email from the organizer, "Now that your satellite's launched, can you come and show us some imagery." "Let's wait until we have the imagery and it's releasable to the public, and I'm happy to come back." So that shows on the public TV stations, seemingly at random times on PBS [Public Broadcasting Service]. In fact, my mother in law, at one point, was like, "What's Tim doing downstairs? Tim's not here." Well, she had the TV on; she left it on to PBS. Then my show came on about weather satellites and about GOES-R. That's out there.

MG: Is there anything else I've forgotten to ask you about?

TS: No, I think we've got it covered. Like I say, I think that working for NOAA is really a chance to have a big impact. Again, we did what we needed to do with our satellites. Some of that then got copied again around the globe. Again, these are operational satellites. So the current satellite series is going to last until 2038. Now we're talking about what's going to be on the next one. I haven't done the math on how long those – so I've always thought, working for NOAA, there's really that multiplier effect, that it's hard to get things done. There's a fair amount of inertia sometimes. But when you get things in, again, it's long-lasting because they are operational satellites. It's not launching one experimental one, and if you had a launch failure, you're done. It's being able to have this data for a long time. That's a real plus, working for NOAA.

MG: Well, this has really been a treat. I want to thank you for all your time, stories, and your contributions to NOAA. I'll turn this off.

TS: Okay.

MG: Thank you.

TS: Yes.

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Reviewed by Molly Graham 11/19/2019
Reviewed by Tim Schmit 11/30/2019
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