EXAMINING THE NATION'S CURRENT AND NEXT GENERATION WEATHER SATELLITE PROGRAMS

HEARING

BEFORE THE

SUBCOMMITTEE ON ENVIRONMENT

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

HOUSE OF REPRESENTATIVES

ONE HUNDRED FOURTEENTH CONGRESS

SECOND SESSION

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July 7, 2016

EXAMINING THE NATION'S CURRENT AND NEXT GENERATION WEATHER SATELLITE PROGRAMS

THURSDAY, JULY 7, 2016

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON ENVIRONMENT,
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY,
Washington, D.C.

The Subcommittee met, pursuant to call, at 10:03 a.m., in Room 2318 of the Rayburn House Office Building, Hon. Jim Bridenstine [Chairman of the Subcommittee] presiding.

LAMAR S. SMITH, Texas
CHAIRMAN

EDDIE BERNICE JOHNSON, Texas
RANKING MEMBER

Congress of the United States
House of Representatives

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
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Subcommittee on Environment

Examining the Nation's Current and Next Generation Weather Satellite Programs

Thursday, July 7, 2016
10:00 a.m. – 12:00 p.m.
2318 Rayburn House Office Building

Witnesses

Dr. Stephen Volz, Assistant Administrator, National Environmental Satellite, Data, and Information Services, National Oceanic and Atmospheric Administration

Mr. David Powner, Director, Information Technology Management Issues, Government Accountability Office

Mr. Ralph Stoffler, Director of Weather, Deputy Chief of Staff for Operations, U.S. Air Force

Ms. Cristina Chaplain, Director, Acquisition and Sourcing Management, Government Accountability Office

U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

HEARING CHARTER

Thursday, July 7, 2016

TO: Members, Committee on Science, Space, and Technology

FROM: Majority Staff, Committee on Science, Space, and Technology

SUBJECT: Environment Subcommittee hearing "Examining the Nation's Current and Next Generation Weather Satellite Programs"

The Subcommittee on Environment will hold a hearing titled *Examining the Nation's Current and Next Generation Weather Satellite Programs* on Thursday, July 7, 2016, at 10:00 a.m. in Room 2318 of the Rayburn House Office Building.

Hearing Purpose:

The purpose of this hearing is to examine the operational and planned weather satellite systems of the United States, as well as the partnerships that ensure accurate and timely forecasting capabilities.

Witness List

- **Dr. Stephen Volz**, Assistant Administrator, National Environmental Satellite, Data, and Information Services, National Oceanic and Atmospheric Administration
- **Mr. David Powner**, Director, Information Technology Management Issues, Government Accountability Office
- **Mr. Ralph Stoffler**, Director of Weather, Deputy Chief of Staff for Operations, U.S. Air Force
- **Ms. Cristina Chaplain**, Director, Acquisition and Sourcing Management, Government Accountability Office

Staff Contact

For questions related to the hearing, please contact Majority Staff at 202-225-6371.

Chairman BRIDENSTINE. The Subcommittee on Environment will come to order. Without objection, the Chair is authorized to declare recesses of the subcommittee at any time.

Welcome to today's hearing entitled "Examining the Nation's Current and Next Generation Weather Satellite Programs." I recognize myself for five minutes for an opening statement.

I'd like to first thank our witnesses for being here today. This committee has a longstanding interest in the weather satellite programs of the National Oceanic and Atmospheric Administration, as evidenced by our continued oversight of these programs spanning multiple Congresses. I am also pleased to have the Department of Defense here today to discuss their weather satellite missions and the cooperation and coordination between the DOD and NOAA that result in expert forecasts that save lives and property.

After the National Polar-Orbiting Operational Environmental Satellite System, NPOESS, partnership failed to curb costs or yield benefits, the Administration directed NOAA and the DOD to develop individual polar-orbiting weather satellite programs. This has come to fruition with NOAA's Joint Polar Satellite System, JPSS, the first of which is slated to launch in March of 2017. Given that we are currently relying on the experimental-turned-operational Suomi NPP, it is my hope that this program suffers no further delays, and this launch date is met.

There has been improvement in the JPSS program over the past few years, but there are still potential causes of concern, which we will explore today. Meanwhile, the DOD began its own weather satellite program, the Defense Weather Satellite System, DWSS. However, this plan was scrapped in 2012, and the Department is now planning a new generation called the Weather System Follow-On, WSF.

In the meantime, the DOD currently relies on its existing satellite system, the Defense Meteorological Satellite Program, DMSP. These DOD satellites, much like NOAA's existing fleet, are ageing rapidly. One of them, DMSP–19, failed earlier this year, increasing the fragility of the system. The possibility of data gaps looms large as both agencies look to create a more robust satellite architecture.

Further complicating these issues is the reliance the agencies place on themselves and our international partners for critical weather data. For polar-orbiting satellite data, there are three primary orbits. The early-morning orbit is operated by the DOD, the mid-morning orbit by EUMETSAT's MetOp program, our partnering satellite agency in Europe, and the early-afternoon orbit by NOAA. Eighty percent of the data that goes into our numerical weather models comes from polar-orbiting satellites. Since we rely so heavily on these satellites, it is important for these orbits to continually be filled.

While these government satellites systems play an important role in providing data that predicts weather, I also want to highlight the growing role of the private sector. Let me be absolutely clear: I am not in any way suggesting the privatization of NOAA. Some people have suggested that, or the National Weather Service. However, the advancements of the commercial weather satellite industry have real potential to improve our forecasting capabilities, as well as provide gap mitigation in the event one of our satellites suffers a failure or further delays.

NOAA has released a Commercial Space Policy, a draft of its Commercial Space Activities Assessment process, and is currently operating a commercial weather data pilot program to test and validate private sector data for integration into its numerical weather models. I applaud NOAA's progress, and look forward to further action on this front. This Committee will remain vigilant in its oversight responsibilities to ensure that Americans have the best possible weather forecasts to save lives and property.

[The prepared statement of Chairman Bridenstine follows:]

COMMITTEE ON
SCIENCE, SPACE, & TECHNOLOGY
Lamar Smith, Chairman

For Immediate Release
July 7, 2016

Media Contacts: Kristina Baum
(202) 225-6371

Statement of Environment Subcommittee Chairman Jim Bridenstine (R-Okla.)
Examining the Nation's Current and Next Generation Weather Satellite Programs

Chairman Bridenstine: Good morning and welcome to this morning's Environment Subcommittee hearing entitled "Examining the Nation's Current and Next Generation Weather Satellite Programs." I'd like to first thank our witnesses for being here today.

This Committee has a longstanding interest in the weather satellite programs of the National Oceanic and Atmospheric Administration, as evidenced by our continued oversight of these programs spanning multiple Congresses. I am also pleased to have the Department of Defense here today to discuss their weather satellite missions and the cooperation between the DOD and NOAA that result in expert forecasts that save lives and property.

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These DOD satellites, much like NOAA's existing fleet, are ageing rapidly. One of them, DMSP-19, failed earlier this year, increasing the fragility of the system. The possibility of data gaps looms large as both agencies look to create a more robust satellite architecture.

Further complicating these issues is the reliance the agencies place on themselves and our international partners for critical weather data. For polar orbiting satellite data, there are three primary orbits. The early-morning orbit is operated by the DOD, the mid-morning orbit by EUMETSAT's MetOp program, our partnering satellite agency in Europe, and the early-afternoon orbit by NOAA. Eighty percent of the data that goes into our numerical weather models comes from polar-orbiting satellites. Since we rely so heavily on these satellites, it is important for these orbits to continually be filled.

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This Committee will remain vigilant in its oversight responsibilities to ensure that Americans have the best possible weather forecasts to save lives and property.

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Chairman BRIDENSTINE. I now recognize the gentlewoman from Oregon, the Ranking Member, Ms. Bonamici, for an opening statement.

Ms. BONAMICI. Thank you very much, Mr. Chairman, and thank you for your ongoing interest in the important issue of improving weather forecasting, and thank you to all of our witnesses for being here today.

The data collected by NOAA's weather satellites are the backbone of NOAA's weather prediction capabilities and support weather forecasting activities around the globe. NOAA, in coordination with its interagency and international partners, is working diligently to move the national weather satellite system into a robust state so we will have the certainty and continuity of accurate and reliable forecasts and severe storm warnings.

In addition to providing uninterrupted weather observations in the near term, NOAA is actively assessing what new capabilities will be required beyond the 2020s to protect American lives and property during extreme weather events. I am looking forward to hearing about both of these efforts.

As we've discussed in the past, however, both the geostationary and polar weather satellite programs—GOES and JPSS—have experienced schedule delays, significant cost growth, technical performance concerns, and management challenges. Although any and all remaining challenges must be addressed, I am pleased to note that NOAA has made significant progress, and we expect to soon be celebrating the successful launches of GOES–R and JPSS–1 satellites.

It is critical that these programs remain on schedule to minimize the potential risk to the collection of observations and data that are needed for NOAA's weather forecasting activities. Even the best-laid plans can be met with unanticipated events, a launch failure, or a potential satellite malfunction, for example. I will be listening for an update on the status of NOAA's contingency plans in the event that we do face a gap in data continuity, and I look forward to hearing about NOAA's efforts to put the weather satellite programs on a path to the robust state that the 2013 independent review team recommended.

In addition, the strength of our civil weather satellite system relies heavily on the interagency and international partnerships that NOAA has in place over decades. This morning's hearing provides the opportunity for us to learn more about NOAA's work with the Department of Defense and the communication among partners on future weather satellite planning efforts.

As we look ahead, NOAA's partnerships are expected to extend to commercial entities. NOAA is taking concrete steps toward implementing its commercial weather data pilot program in response to direction in the fiscal year 2016 Omnibus Appropriations Act. In fact, I understand that Dr. Volz will be attending an industry day workshop immediately following our hearing where he will receive feedback from companies interested in participating in the pilot program. I'm encouraged that NOAA has implemented the commercial weather data pilot program promptly and has provided an open dialogue throughout the process.

Finally, the planned launches of both GOES–R and JPSS–1 satellites should not mark the conclusion of NOAA's programmatic efforts but rather should be the figurative launching pad of the planning and development of our next generation of weather satellites. I look forward to hearing about both NOAA's polar follow-on program and its long-term architecture plans.

And before I yield back the balance of my time, I'm going to note, Mr. Chairman, I do need to run to a markup, and I'm going to do my best to get back as soon as possible. My colleague Mr. Grayson will take over until I can get back.

And I yield back. Thank you, Mr. Chairman.

[The prepared statement of Ms. Bonamici follows:]

OPENING STATEMENT
Ranking Member Suzanne Bonamici (D-OR)
of the Subcommittee on Environment

House Committee on Science, Space, and Technology
Subcommittee on Environment
"Examining the Nation's Current and Next Generation Weather Satellite Programs"
July 7, 2016

Thank you, Mr. Chairman. And thank you to our witnesses for being here today.

The data collected by NOAA's weather satellites are the backbone of NOAA's weather prediction capabilities and support weather forecasting activities around the globe.

NOAA, in coordination with its interagency and international partners, is working diligently to move the national weather satellite system into a robust state so we will have certainty and continuity of accurate and reliable forecasts and severe storm warnings. In addition to providing uninterrupted weather observations in the near term, NOAA is actively assessing what new capabilities will be required, beyond the 2020s, to protect American lives and property during extreme weather events. I am looking forward to hearing about both of these efforts.

As we have discussed in the past, however, both the geostationary and polar weather satellite programs, GOES and J-P-S-S, have experienced schedule delays, significant cost growth, technical performance concerns, and management challenges. Although any and all remaining challenges must be addressed, I am pleased to note that NOAA has made significant progress, and we expect to soon be celebrating the successful launches of the GOES-R and JPSS-1 satellites.

It is critical that these programs remain on schedule to minimize the potential risk to the collection of observations and data that are needed for NOAA's weather forecasting activities. Even the best laid plans can be met with unanticipated events—a launch failure or potential satellite malfunction, for example. I will be listening for an update on the status of NOAA's contingency plans in the event that we do face a gap in data continuity and I look forward to hearing about NOAA's efforts to put the weather satellite programs on a path to the "robust" state that the 2013 Independent Review Team recommended.

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I yield back the balance of my time.

Chairman BRIDENSTINE. The gentlelady yields back.

I'd like to now recognize the Ranking Member of the full Committee, Ms. Johnson, for a five-minute opening statement.

Ms. JOHNSON. Thank you very much, Mr. Chairman.

Let me welcome the witnesses, and I'm pleased to see that Dr. Volz and Dr. Powner are here again to provide updates on our nation's critical weather satellite development programs, JPSS and GOES–R. I am looking forward to hearing from both of you and Mr. Stoffler and Ms. Chaplain about the relationship between the Department of Defense and NOAA and how that partnership helps meet both civilian and defense needs.

I want to be clear that NOAA's weather satellite programs play a critical role in ensuring the continued health of our weather forecasting capabilities, and they support weather forecasting activities around the globe. Although both JPSS and GOES–R has experienced significant cost growth and management and technical challenges during this development, I am pleased to learn that NOAA has responded to recommendations from GAO and others and that we expect to have both satellites launched within the year.

However, as we will hear today, there is still more work to be done. Concerns about a potential gap in our satellite coverage must be addressed and NOAA must apply lessons learned to ensure future programs do not face identical challenges.

As I've said before, we must take all necessary steps to ensure that there is not a gap in satellite coverage in support of our weather forecasting capabilities. The successful launch of these satellites is critical to ensure our nation maintains its weather forecasting capabilities. However, it represents the first step, not the last in NOAA's ever-evolving efforts to protect American lives, property, and critical infrastructure.

I look forward to hearing more about NOAA's plans to maintain and improve the Nation's weather forecasting capabilities. I thank you, Mr. Chairman, for holding the hearing, and I yield back the balance of my time.

[The prepared statement of Ms. Johnson follows:]

OPENING STATEMENT
Ranking Member Eddie Bernice Johnson (D-TX)

House Committee on Science, Space, and Technology
Subcommittee on Environment
"Examining the Nation's Current and Next Generation Weather Satellite Programs"
July 7, 2016

Thank you, Mr. Chairman, and welcome to our witnesses. I am pleased to see both Dr. Volz and Mr. Powner here again to provide updates on our Nation's critical weather satellite development programs – J-P-S-S and GOES-R. I am also looking forward to hearing from both Mr. Stoffler and Ms. Chaplain about the relationship between the Department of Defense and NOAA, and how that partnership helps meet both civilian and defense needs.

Let me be clear: NOAA's weather satellite programs play a critical role in ensuring the continued health of our weather forecasting capabilities, and they support weather forecasting activities around the globe.

Although both J-P-S-S and GOES-R have experienced significant cost growth, and management and technical challenges during their development, I am pleased to learn that NOAA has responded to recommendations from GAO and others, and that we expect to have both satellites launched within the year.

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The successful launch of these satellites is critical to ensure our Nation maintains its weather forecasting capabilities. However, it represents the first step, not the last, in NOAA's ever evolving efforts to protect the American lives, property, and critical infrastructure. I look forward to hearing more about NOAA's plans to maintain and improve the Nation's weather forecasting capabilities.

Thank you, Mr. Chairman, and I yield back the balance of my time.

Chairman BRIDENSTINE. I'd like to thank the Ranking Member for her opening statement.

I'd like to introduce our witnesses today. Our first witness today is Dr. Stephen Volz, Assistant Administrator for the National Environmental Satellite Data and Information Services at the National Oceanic and Atmospheric Administration. Dr. Volz has a doctorate in experimental condensed matter physics from the University of Illinois at Urbana-Champaign and a master's in physics from Illinois and a bachelor's in physics from the University of Virginia.

Our next witness today is Mr. David Powner, Director of Information Technology Management Issues at the Government Accountability Office. Mr. Powner received his bachelor's degree in business administration from the University of Denver and attended the Senior Executive Fellows Program at Harvard University.

Our third witness today is Mr. Ralph Stoffler, Director of Weather and Deputy Chief Of Staff for Operations at the U.S. Air Force. Mr. Stoffler received his bachelor's of science in meteorology from the University of Oklahoma in Norman—Boomer—and his master's degree in systems management from the University of Southern California Los Angeles.

Our final witness today is Ms. Cristina Chaplain, Director of Acquisition and Sourcing Management at the Government Accountability Office. Ms. Chaplain received her bachelor's degree magna cum laude in international relations from Boston University and her master's degree in journalism from Columbia University.

I'd like to now recognize Dr. Volz for a five-minute opening statement.

TESTIMONY OF DR. STEPHEN VOLZ, ASSISTANT ADMINISTRATOR, NATIONAL ENVIRONMENTAL SATELLITE, DATA, AND INFORMATION SERVICES, NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

Dr. VOLZ. Good morning, Chairman Bridenstine, Ranking Member Bonamici, who unfortunately had to depart, and Members of the Committee. I'm Dr. Stephen Volz, as indicated, Assistant Administrator for NOAA's Satellite, Environmental, Data, and Information Service called NESDIS.

The United States depends on NOAA to collect and provide the critical Earth observations and information needed for weather forecasts, for disaster preparedness, all-hazards response and recovery, for the protection of critical infrastructure and natural resources, and also for the continued economic vitality of the nation.

Currently, NOAA's observation portfolio is strong and will soon be even stronger. NOAA has launched, with support from our partners, international and interagency, two missions over the last 18 months, first, the space weather Deep Space Climate Observing—Observatory satellite or DSCOVR in February of 2015 and also the ocean-observing satellite Jason-3 just earlier this year.

Within the next year, NOAA plans to launch the next-generation geostationary and polar-orbiting environmental satellites GOES–R and JPSS–1 and the COSMIC–2A radio occultation constellation of satellites. These launches are only the beginning of a series of next-generation satellites soon to take flight.

But a significant portion of what NESDIS does is not just in space. All elements of the integrated observing system with satellites, ground operations, assured satellite communications, reliable data archives are essential for our continued mission success. Beginning with the launch of JPSS–1, NESDIS will bring online in stages, a new upgraded ground operating system with enhanced reliability security, and lower data latency. This ground system will operate, ingest, and process data, providing information to users around the globe.

Similarly, for GOES–R we're deploying six new ground antennae enhanced to handle the increased data rate expected from GOES–R while staying within the narrow accessible frequency range allowed for our satellite transmissions.

In fiscal year 2016, NOAA received funding from Congress to initiate the polar follow-on, the extension of the polar constellation. With this critical funding, the JPSS program now includes five polar-orbiting satellites, Suomi NPP, JPSS–1, 2, 3, and 4. This series of satellites supported by a NOAA industrial collaboration over the past years and into the future years is making excellent progress now on the Polar Follow-On, procuring the critical instrument long lead items so that we can ensure the delivery of these satellites on cost and on schedule.

Earth's weather systems are a global phenomenon, and NOAA's satellites are only one piece of a global observing constellation. We are able to accomplish what we do because our many productive and mutually beneficial scientific and operations partnerships built up over years of cooperation and formal agreements that are underpinned by a full, open, and timely data-sharing policy. These partnerships allow us to ensure the continued operation of the robust global constellation needed to meet the needs of our users and stakeholders.

In order to produce trusted, reliable data that our nation depends on every day, quality, validated observations are needed from multiple polar orbits, as Mr. Chairman Bridenstine mentioned. Continuing our partnerships now 30 years strong, NOAA and the European Organisation for the Exploitation of Meteorological Satellites, or EUMETSAT, have agreed to share the burden of the polar-orbiting satellite for the next 25 years. NOAA and EUMETSAT will continue splitting coverage for the two primary orbits, the midmorning and afternoon, and openly sharing data from our—with our respective missions.

Within the United States, interagency collaboration allows us to leverage the capabilities, the capacity, and the infrastructure of other U.S. agencies such as with NASA, which is NOAA's acquisition agent, and with the Department of Defense. The United States Air Force Defense Meteorological Satellite Program, or DMSP satellites, provide observations for the third early-morning orbit that is important for us. And NOAA operates the ground system development and oversees daily operations of the DMSP satellites out of our NOAA Satellite Ops Facility in Suitland, Maryland. These partnerships continue to provide excellent value for the U.S. Government as a whole.

Looking to the future, we are now preparing for the future observing system, evaluating changes in technology, emerging partnership opportunities, and national trends. Partnerships with the commercial sector and academic institutions can provide flexibility, including more innovative observing approaches, potentially enhancing our overall observing system reliability.

This year, through the Commercial Weather Data Pilot, NESDIS is working with the emerging commercial Earth observation community to explore the present capabilities to meet NOAA's observing requirements. Our comprehensive system study will consider all sources as we map out the observing system of the future. Our goal is to deploy an observing system within stable budget requirements but which is also agile and resilient and is responsive to the rapidly changing capabilities and technology of the future.

We appreciate Congress' strong support and we look forward to answering questions during the hearing today. Thank you, sir.

[The prepared statement of Dr. Volz follows:]

WRITTEN STATEMENT BY
STEPHEN M. VOLZ
ASSISTANT ADMINISTRATOR
NATIONAL ENVIRONMENTAL SATELLITE, DATA, AND INFORMATION SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

HEARING TITLED
EXAMINING THE NATION'S CURRENT AND NEXT GENERATION WEATHER SATELLITE PROGRAMS
BEFORE THE
SUBCOMMITTEE ON ENVIRONMENT
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

July 7, 2016

Chairmen Bridenstine, Ranking Members Bonamici, and Members of the Committee, I am Dr. Stephen Volz, the Assistant Administrator of NOAA's National Environmental Satellite, Data, and Information Service (NESDIS). Thank you for the opportunity to participate in today's hearing, and I am pleased to join the other witnesses – Mr. Stoffler from the United States Air Force (USAF), and Mr. Powner and Ms. Chaplain from the Government Accountability Office.

NESDIS supports NOAA's mission of science, service, and stewardship through our satellite missions, data centers, data and information products, services, and use-inspired science. It is an end-to-end responsibility that underpins NOAA's value to the Nation. The United States depends on NOAA to provide satellite data and imagery for meteorological and space weather forecasts and emergency services. NESDIS' responsibility is to collect and provide the critical satellite Earth observations and other essential environmental information needed for disaster preparedness, all hazards response and recovery, and the protection of the Nation's critical infrastructure and natural resources. The 24 hours-per-day, 7 days-per-week, 365 days-per-year global coverage provided by NESDIS generates an uninterrupted stream of environmental data products. These products and information enable services used across the country in preparation for weather, oceans, and climate events that impact our daily lives, and national safety, and provide essential information for national, regional, and local emergency managers and officials.

The reach of NESDIS extends across many weather and hazard events, from supporting the forecasting of severe droughts in California to monitoring ash from volcanic eruptions over the Alaska Peninsula. Our nation's most dangerous and costly hurricanes have been closely monitored by forecasters and the general public alike using observations and analyses based on data from NESDIS satellites. NESDIS data and information also provide foundational support for a constantly evolving array of applications and products used for the monitoring and research of Earth and its space environment. All of this is achieved through an increasingly capable global constellation of environmental satellites.

While NOAA continues to provide the highly accurate and reliable delivery of data, information, products, and services the organization is known for, we are now also taking time to assess the current state of the enterprise and evaluate changing technology, emerging partnership opportunities, and national trends. In the coming years, NOAA's satellite constellation will undergo significant enhancements and experience fundamental changes. NOAA's satellite systems are moving beyond the operation of distinct and separate observing systems to an integrated global observation system that can more efficiently merge observations from polar and low-Earth orbits with geostationary and other orbits, and that is sensitive to emerging technologies in both satellite and ground systems.

NOAA's Current Satellite Observation enterprise

The breadth of space-based observational capabilities and observing platforms operated by NOAA ranges from satellites in the polar orbit - providing global coverage - such as the NOAA/NASA Suomi National Polar-orbiting Partnership (Suomi NPP), Jason-2 and-3, Polar-orbiting Operational Environmental Satellites (POES), and the Defense Meteorological Satellite Program (DMSP), to satellites in geostationary orbit, such as NOAA's Geostationary Operational Environmental Satellites (GOES) - providing regional coverage - which orbit nearly 22,240 miles away, and the nation's first operational satellite in deep space, the Deep Space Climate Observatory (DSCOVR), nearly one million miles away, midway between the Sun and the Earth.

Polar and Low-Earth Orbit Satellites

NOAA's polar-orbiting operational environmental satellites provide full global coverage for a broad range of weather and environmental applications, supporting both short-term weather forecasting and long-term climate records. NOAA's current operational polar-orbiting satellites include NOAA-15, NOAA-18, NOAA-19, and Suomi NPP.

Placed in the afternoon orbit, the NOAA/NASA Suomi NPP satellite is NOAA's primary operational polar-orbiting spacecraft and provides critical observations to support NOAA's three to seven-day operational weather forecasts, operational weather "nowcasting" in Alaska and polar regions, and environmental monitoring and prediction. Launched in October 2011, Suomi NPP's Advanced Technology Microwave Sounder and Cross-track Infrared Sounder instruments provide data to NOAA's operational numerical weather prediction models. The Visible Infrared Imaging Radiometer Suite instrument provides a wide range of environmental observations, data, and imaging capabilities including critical environmental products relating to snow and ice cover, clouds, fog, aerosols, fire, smoke plumes, dust, vegetation health, phytoplankton abundance, and chlorophyll. The satellite also includes the Ozone Mapping and Profiler Suite which takes global measurements of stratospheric ozone levels. Combined, these instruments have revolutionized forecasters' ability to make long range forecasts.

The NOAA/NASA Suomi NPP satellite continues to function well, completing its fourth year on orbit on October 28, 2015. The vehicle and instruments are all operating within specifications, though the scan drive motor on the ATMS instrument is showing signs of aging. A program of drive motor reversals was undertaken last year in order to extend the life of the motor.

Also in low-Earth orbit, NOAA operates both the Jason-2 and Jason-3 satellites as part of the international Ocean Surface Topography Mission. The Jason mission is a partnership among NASA, France's Centre National d'Etudes Spatiales (CNES), the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT), and NOAA NESDIS. The Jason satellites provide sea surface height measurements using satellite altimetry. These data, provided operationally with a low latency, are used in studies and forecasts for tsunami dynamics, El Niño Southern Oscillation, eddy dynamics, ocean boundary currents and coastal and shallow water tides. Ocean heat content is also derived from Jason observations, and is an important factor in magnifying hurricane intensity, and impact to coastal communities such as the Gulf Coast states and eastern seaboard. The U.S. Navy's ability to conduct tactical and strategic operational planning depends upon accurate ocean models that include satellite altimetry data. On June 1, 2016, CNES handed NOAA official operational control of the Jason-3 satellite which is now taking operational, highly-detailed measurements in conjunction with Jason-2.

The Constellation Observing System for Meteorology, Ionosphere, and Climate (COSMIC) mission, a joint research mission between the United States and the National Space Organization of Taiwan (NSPO), launched six satellites in a low-Earth orbit constellation in 2006. COSMIC data are used to provide three-dimensional profiles of temperature, humidity, and pressure measurements of the atmosphere, and provide electron density in the ionosphere. COSMIC data provide measurements of these atmospheric qualities in a manner complementary and independent of observations from the Suomi NPP satellite. Data collected by COSMIC are especially useful for forecasting tropical cyclones, including typhoons and hurricanes, because COSMIC is able to provide critical observations of water vapor, the fuel that drives tropical cyclones. These measurements are high resolution in the vertical direction, allowing scientists to determine how much water is present at what height in the atmosphere. The COSMIC satellites are aging, and currently only four of the original six are operating.

Geostationary Operational Environmental Satellites

In geostationary orbit, NESDIS operates GOES-13 in the "GOES-East" position at 75° W and GOES-15 in the "GOES-West" position at 135° W. GOES-14 is available as an on-orbit spare, located at 105° W.

NOAA's two operational GOES satellites provide consistent and reliable monitoring of the entire Western Hemisphere and are critical for identifying and tracking severe weather, snow storms, and tropical cyclones. In addition to providing crucial near-real time imagery, on-board sensors detect cloud formation, land and ocean temperatures, as well as monitor activities of the sun like solar flares, which can disturb Earth's magnetic field. NOAA also uses GOES to identify when emergency locator beacons on ships and planes or with hikers and snowmobilers have been activated. The GOES satellites relay the alert to first responders so that they may initiate search and rescue activities, while the SARSAT instruments on the NOAA POES and EUMETSAT Metop satellites provide precise locations of activated beacons.

GOES-East and GOES-West are providing data every 15 minutes to weather forecasters to support their forecasts and warnings. Although GOES-West experienced a component anomaly (i.e., loss of one of the two remaining star trackers) in April 2015, the satellite continues to operate on the single remaining star tracker and continues to meet all user performance requirements. The GOES-West Solar X-Ray Imager and X-Ray Sensor are acting as primary instruments, providing operational measurements, for NOAA's Space Weather Prediction Center. In November 2015, the GOES-East sounder filter wheel stalled. However, the imager continues to operate normally and is meeting all essential NWS weather forecasting needs. The current on-orbit spare, GOES-14, is in normal configuration, instead of storage mode configuration, to provide quick services as a backup. GOES-14 has been periodically providing 1-minute Super Rapid Scan Operations to help algorithm developers, research partners, and forecasters prepare for the advanced capabilities available on the next-generation R-series geostationary satellites. All of the GOES-14 payload instruments are fully functioning without any performance degradation.

DSCOVR

NOAA's DSCOVR satellite is currently positioned approximately one million miles away in order to meet NOAA's operational requirement for continuous measurement of solar wind. The DSCOVR satellite will become the nation's first operational deep space satellite later this month, when NOAA's Space Weather Prediction Center expects to officially transition their operational solar wind data from NASA's Advanced Composition Explorer research satellite to data provided by DSCOVR.

National Centers for Environmental Information

These observing systems generate comprehensive environmental observations that are integrated and harmonized with other data collected by NOAA observing systems (e.g. radars, ships, buoys, aircraft, etc.) and observing systems operated by other nations. These data form the basis of the most comprehensive collection of national and global Earth environmental observations available for retrospective analyses and applications. NESDIS is the official source for atmospheric and space weather, climate, coastal, oceanographic, and geophysical environmental data and information. Access to reliable and accurate long-term records of this data and information is critical to satisfying the Nation's wide range of businesses, education, and government needs, including policies and decisions that have an impact on water and energy management, manufacturing, transportation, defense, food production, public health, and many other socio-economic issues. NESDIS' authoritative data and information products enable decision makers to make confident knowledge-based determinations about maximizing opportunities and minimizing threats from the environment.

<u>The Future of NESDIS Data and Observational Systems</u>

Next Generation Satellite Systems

With the next generation of environmental observation satellites on the horizon, NOAA is poised to once again significantly improve weather forecasting and severe weather prediction. The DSCOVR satellite lifted off from Cape Canaveral Air Force Station on February 11, 2015, and Jason-3 was launched less than a year later on January 17, 2016. Within the next year, NOAA plans to launch GOES-R, JPSS-1, and the first six COSMIC-2 satellites, which is the next step in building NOAA's future constellation.

The first satellite in NOAA's next generation geostationary satellite series, GOES-R, is scheduled to launch November 4, 2016. It will be known as GOES-16 once operational, and will scan Earth five times faster at four times the image resolution and triple the number of spectral channels than the current GOES generation. This increase in data and information means improved satellite imagery of severe weather will be available, giving forecasters even more tools to issue timely warnings during severe weather events. In addition, improved space weather observations from GOES-R will complement those from the newly launched DSCOVR mission, providing a comprehensive look at incoming solar storms and at the underlying solar activity that generates these storms.

The GOES-R Series will also carry the first lightning mapper ever flown in geostationary orbit. The revolutionary Geostationary Lightning Mapper (GLM) will map total lightning (in-cloud and cloud-to-ground) continuously over the Americas and adjacent ocean regions providing hemispherical lightning observations for the first time. Increases in lightning flash rate are often a predictor of impending severe weather, meaning the total lightning data from GLM has the potential to increase lead time for the issuance of severe thunderstorm and tornado warnings.

Following GOES-R, NOAA's JPSS-1 satellite is scheduled for launch no later than the second quarter of FY 2017. Once operational, the satellite will be known as NOAA-20. JPSS-1 has five highly-sensitive instruments on board, the same type as those currently being successfully flown on the NOAA/NASA Suomi NPP satellite. Five years of operations with the NOAA/NASA Suomi NPP satellite have prepared NESDIS, and its users, for the great performance and value of this breakthrough operational polar-orbiting satellite. With the launch of JPSS-1, NESDIS will deliver to operations a new, upgraded ground system with enhanced reliability, security, and data timeliness. This system will not only operate NOAA's JPSS-1, Suomi NPP, and other polar-orbiting spacecraft, but will also ingest and process their data, providing information to users around the globe.

After commissioning is completed, the JPSS-1 satellite will fly one half orbit ahead of Suomi NPP in the same orbital plane. This means that JPSS-1 will operate about 50 minutes ahead of Suomi NPP, allowing for important overlap in observational coverage. The data from both satellites will provide critical observations and continue to be entered into National Weather Service numerical weather prediction models, thereby continuing the improvements in medium and long-term weather forecasts and severe weather prediction.

Launched on April 15, 2006, four of the six COSMIC satellites are operating six years beyond their design life and are in need of replacement. In order to maintain and increase the level of coverage provided, NOAA plans to launch COSMIC-2A in early 2017 and is considering COSMIC-2B in 2020 (contingent on the outcome of an ongoing evaluation of possible commercial solutions). The COSMIC-2 constellation will include advanced technology that will significantly increase the geographic coverage, quantity, and quality of observations. Under a partnership agreement between the United States (NOAA and the USAF) and NSPO, the COSMIC-2 mission will develop and deploy an operational constellation of 12 Global

Navigation Satellite System (GNSS) Radio Occultation satellites. The first six will be launched into an equatorial orbit and augment the current COSMIC satellites. Replacement of the polar-orbit could occur through a commercial data buy or could be satisfied through launch of COSMIC-2B into polar-orbit to replace the aging COSMIC satellites. The COSMIC-2 program is expected to provide up to 8,000 temperature and humidity measurements worldwide per day, almost ten times the number of daily measurements that COSMIC-1 currently provides, which we anticipate will increase the benefits to weather forecasting. If the GNSS RO polar-orbit data are not replaced before the remaining four COSMIC satellites fail, there may be degradation to NWS forecasts.

These launches are only the beginning of a series of next-generation environmental observing satellites to take flight. Development of both the GOES-R Series and JPSS satellites are in progress. GOES-S is nearing completion of satellite integration and preparations for its environmental test campaign, while the GOES-T and –U component development is well underway. JPSS-1 took another step closer to its launch in early 2017 with the integration of its fifth and final instrument in February 2016. In April 2016, the satellite began environmental testing, the next step in launch preparation. All four JPSS-2 instruments are in the parts procurement, sub-assembly integration, and test phase. Some significant risks have been successfully addressed as these instruments progress. The spacecraft work for JPSS-2 was initiated in July 2015, and the first review milestone for it was successfully conducted last fall.

NOAA has also received funding and approval from Congress in the FY 2016 appropriations bill for the JPSS Program to initiate the Polar Follow On (PFO) JPSS-3 and JPSS-4 satellites. With this funding, the JPSS Program now includes five polar-orbiting satellites, each with critical sounding and imaging instruments, and a versatile ground segment. These are: Suomi NPP, JPSS-1, JPSS-2, JPSS-3, and JPSS-4. They enable the JPSS program to provide polar coverage through the 2030s to ensure continuity and robustness of critical polar-orbiting weather satellite observations.

The President's FY 2017 budget has proposed $393 million for the development of JPSS-3 and -4. This is an increase of $23 million from the 2016 enacted budget for PFO, and it shows continued commitment by the Administration to this critical program that will help to sustain coverage of the afternoon polar orbit that is so critical to U.S. weather forecasting.

Enterprise Ground and Space Architectures

A significant portion of what NESDIS does is not just in space, but on the ground as well. Everything from satellite operations to data ingestion, validation and calibration, distribution, product development, and archiving occur through ground systems and data management centers. NESDIS is preparing for the future by integrating ground services in order to leverage technology to achieve efficiencies, accelerate the development and delivery of operational products, reduce cost and risk, and consolidate functions where possible, while improving cybersecurity, communications and data archiving capabilities. In order to facilitate the development of integrated systems and the creation of state-of-the-art science products, NESDIS has already begun a transition to enterprise algorithms. Currently, work is being conducted to update NOAA Heritage Cloud, Cryosphere, Volcanic Ash, and Aerosol algorithms to work on data from JPSS satellites and to migrate software databases for several POES and GOES algorithms in order to bring consistency across the GOES-R and JPSS suite of products. NESDIS is also ensuring user readiness not only with the NWS, but also to meet the broad set of NOAA mission needs across the National Ocean Service, the National Marine Fisheries Service, and the Office of Marine and Aviation Operations.

Architecture Studies and Future Planning

In 2015, NESDIS began a comprehensive review of all observing system requirements and capabilities to determine potential challenges and begin identifying possible solutions. The purpose of the NOAA Satellite Observing System Architecture Study is to determine the most cost effective space segment architecture for performing NOAA weather, space weather, and environmental remote sensing missions, beyond the current program of record for operations beginning in the 2030s. The study is working to identify the user needs that drive NOAA missions and develop new concepts and options for Earth observing instruments and their space-based platforms. This also means conducting observing system analyses while considering system complexity, cost, risk, and launch options. The goal is to seek and maintain constellations which can be met with stable budget requirements, and which are agile and resilient.

Partnerships

The combined effect of NOAA's next generation of GOES-R Series and JPSS/PFO satellites will provide a significant improvement over NOAA's previous observing capabilities and will provide critical observations through the mid-2030s. Earth's weather systems are a global phenomenon, however, and NOAA's satellites are only one piece of the global observing constellation.

NOAA and NESDIS accomplish much of what we do because of the scientific and data exchange with our partners, built on years of cooperation and formal agreements that are underpinned by a full, open, and timely data sharing policy. Successful partnerships allow us to meet our mission cost-effectively and to be more responsive to the needs of our users and stakeholders. Our key foreign partners, including Europe and Japan, maintain very capable and reliable observation systems, providing NOAA access to their critical data at no charge. To support this international collaboration, the NOAA coordinates global solutions to shared challenges through multilateral organizations, maintaining and expanding bilateral partnerships, and continually promoting the adoption of full and open data policies.

In addition, interagency collaboration allows us to leverage the capabilities, capacity, and/or infrastructure of other U.S. agencies in support of the NESDIS mission, and vice versa. These partnerships have the potential to provide a better return on investment for the U.S. Government as a whole.

Currently, NOAA shares data, and sometimes instruments, with several international satellite programs. In return, NOAA receives access to *in situ* data from countries around the world, and satellite data from missions including the Meteosat and Metop series of satellites from EUMETSAT, Himawari-8 from the Japan Meteorological Agency (JMA), GCOM-W1 from the

Japan Aerospace Exploration Agency, COSMIC from the National Space Organization of Taiwan (NSPO), the Sentinel series from the European Commission and Jason-2 and -3 in partnership with NASA, CNES, and EUMETSAT. The Argos program, which represents one of these long standing collaborative efforts, has lasted over 30 years and is utilized for wildlife tracking, weather buoys, and other environmentally-critical assets. Our partners for the Argos program include the CNES, EUMETSAT, and the Indian Space Research Organisation (ISRO). Cospas-Sarsat is another example of a shared international satellite resource that aides in a search and rescue system, with NOAA providing a platform on our space vehicles for partnering instruments. The governing parties of the system are the U.S. (NOAA), France (CNES), Russia (Morsviazsputnik), and Canada (National Search-and-Rescue Secretariat) and are the signatories to the *International Cospas-Sarsat Programme Agreement* (ICSPA, 1988).The future of robust and cost-effective global Earth observation relies on the continuation of existing, and the cultivation of future, interagency and international partnerships.

In order to produce the three- to seven-day weather outlooks that our nation depends on every day, data and information are needed from three complementary polar orbits. In order to provide these forecasts, critical for the timely notice of severe weather events, NOAA and EUMETSAT have agreed to share the burden of operating polar-orbiting satellites for the next twenty five years. Under this agreement, known as the Joint Polar System Agreement, NOAA and EUMETSAT will split responsibility for the two primary orbits and agree to openly share data from our respective missions. EUMETSAT satellites cover the mid-morning orbit while NOAA is responsible for the afternoon orbit—continuing a partnership that began under the 1998 Initial Joint Polar-orbiting Operational Satellite System Agreement. NWS Alaska region has used imagery from the USAF DMSP to supplement imagery from NOAA POES and Suomi NPP and Metop satellites. Recently, NOAA has included some DMSP data from the third orbit, early morning, into its NWP models. While these data have been available, the DMSP data are not optimized for input into the NWS NWP, therefore, loss of the data would not degrade the model output. NOAA is monitoring the development of the Weather Satellite Follow On to determine how and whether these data could be useful for NWP.

NOAA's geostationary satellites join the EUMETSAT's Meteosat satellites and JMA's Himawari-8 satellite to form a virtual global geostationary constellation. This coordinated global constellation is reinforced by mutually supportive back-up agreements between NOAA and JMA and NOAA and EUMETSAT in recognition of the necessity of a global commitment to uninterrupted observations, and the full, open, and timely sharing of global environmental data and information.

Within the United States, NOAA has strategic partnerships with both NASA and the Department of Defense to achieve the level of robust and reliable Earth observations required by the nation at all times. We have been working closely with NASA, our acquisition partner, to build and operate NOAA's next-generation operational environmental satellite constellations, the JPSS and GOES-R Series programs.

NOAA also works closely with the USAF on several missions in a coordinated project-based partnership. Primary command and control for the USAF's DMSP is jointly managed by NOAA and the USAF 50th Operations Group Detachment 1, both operating out of NOAA's Satellite

Operations Facility in Suitland, Maryland. NOAA specifically operates the ground systems development and oversees daily operation of the DMSP satellites. Operations are also supported by a back-up facility located at Schriever Air Force Base in Colorado Springs, Colorado, under the leadership of the 6th Space Operations Squadron.

Five USAF DMSP satellites, launched between 1997 and 2009, are currently operational. Flying in the early-morning polar orbit, these satellites monitor global information such as clouds, precipitation, ice, snow cover, temperature, water vapor, and wind speed, and are essential contributors to the global polar constellation.

Another coordinated project, the DSCOVR mission, is a partnership between NOAA, NASA and the USAF. NOAA is responsible for operating the satellite as well as processing, distributing, and archiving the data, while NASA held the responsibility of preparing the spacecraft and its instruments (with support from NOAA), developing the ground segment, and managing the launch and activation. The USAF funded and oversaw the launch services for the spacecraft and provided the launch vehicle, a Falcon 9 Rocket, via their launch services contract with SpaceX.

The USAF is also partnering with NOAA, NASA, and NSPO to launch and operate COSMIC-2. The USAF will provide two space weather payloads that will fly on the first six satellites (COSMIC-2A). These include the Radio Frequency Beacon transmitter and the Ion Velocity Meter instruments.

NOAA has partnered with CNES, the Department of National Defense of Canada (DND), and the USAF in the Cooperative Data and Rescue Series program for the continuity of the Argos data collection and the Search and Rescue Satellite Aided Tracking (SARSAT) missions from polar orbiting satellites. CNES and DND have built the Argos and SARSAT payloads, and NOAA is developing plans with USAF to integrate these sensors onto a commercially hosted payload via the USAF Hosted Payload Solutions contract. Execution of this program, with a launch readiness date in early FY 2021, will ensure continuity of both the Argos and SARSAT missions.

Future Commercial Partnerships

The first 50 years of satellite weather observations have been dominated by government observing systems, assets, and partnerships. However, the environmental observing community is now on the cusp of a shift in space-based weather observations toward commercialization. We recognize that partnerships with the commercial sector and academic institutions could provide flexibility and allow for innovative approaches to augmenting and potentially fulfilling national observing requirements more easily.

For NOAA, this opens up the possibility that some environmental observation requirements may be met or supported by observations obtained from commercially owned and operated observing systems. To explore this possibility effectively, NOAA has developed a Commercial Space Policy, which details the principles the agency will apply when considering commercial solutions to meet mission requirements. NESDIS, in accordance with the policy, is developing the Commercial Space Activities Assessment Process that will guide our engagements with industry as new space systems are defined, developed, and deployed. Engagement with the commercial sector involves an open dialogue in which mission requirements are explained and updated, and the production processes and contractual relationships are clearly defined. Underpinning this dialog, and NESDIS' observatory system planning, is a commitment to continue delivering essential products and services to the National Weather Service, and other key users, without interruption or degradation.

On May 24, 2016, NESDIS released a Request for Information (RFI), which closed on June 13, 2016, to support NOAA's Commercial Weather Data Pilot (CWDP) and to assess GNSS RO commercial opportunities to meet NOAA's needs. The CWDP will evaluate commercial data to demonstrate the quality of the data and its impact on weather forecast models, as well as informing NOAA's process for ingesting, evaluating, and utilizing commercial data in the future. The RFI is the first step to potentially bring radio occultation data from commercial companies to NOAA. The RFI seeks pre-launch data in order to facilitate broad participation and will gather the latest industry input as we consider what criteria will be included in a subsequent Request for Proposals (RFP), the next step in carrying out the Pilot. NOAA will use the results of the FY 2016 CWDP to inform how funds will be spent on commercial sources of data. In FY 2017, the President's Budget requests funding to continue activities started in CWDP in FY 2016, and provides an opportunity for NOAA to assess whether to acquire Global Navigation Satellite Systems radio occultation instruments for COSMIC-2B mission or to pursue a GNSS RO commercial data buy.

Conclusion

The importance of environmental satellites to monitor and understand our planet's complex systems was realized over 50 years ago with the launch of the world's first weather satellite. Since then, that single satellite has grown into a global network of systems with increasingly capable satellites, models, and processing and distribution systems that provide an ever growing catalog of products, information and services. Along with the rest of the environmental observing community, NOAA's NESDIS has continued to evolve, becoming a leader in this global endeavor.

Looking toward the future, NESDIS will continue to effectively provide the highly accurate and consistent delivery of data, information, products, and services that our users expect and the Nation depends on, while developing future systems to respond to changing technology, emerging partnership opportunities, and national trends.

With several of NOAA's next generation weather and climate satellites (including JPSS-1, COSMIC-2 and GOES-R) set to launch in the near future, similar constellation growth is occurring within our partner organizations, as well as an emerging relationship with the commercial sector and an increased focus on data integration, curation and fusion, this is a particularly exciting and evolutionary time for NESDIS and the global observing system.

SUMMARY WRITTEN STATEMENT BY STEPHEN M. VOLZ

NESDIS supports NOAA's mission of science, service, and stewardship through our satellite missions, data centers, data and information products, services, and use-inspired science. It is an end-to-end responsibility that underpins NOAA's value to the Nation. NESDIS' responsibility is to collect and provide the critical satellite Earth observations and other essential environmental information needed for disaster preparedness, all hazards response and recovery, and the protection of the Nation's critical infrastructure and natural resources. These products and information enable services used across the country in preparation for weather, oceans, and climate events that impact our daily lives, and national safety, and provide essential information for national, regional, and local emergency managers and officials. NOAA acquires data from its own systems and through domestic and international partnerships.

NESDIS utilizes imagery and data for numerical weather prediction models from polar-orbit (NOAA Suomi NPP, EUMETSAT Metop, joint US-French-EUMETSAT Jason-3 and -3, NOAA POES, Air Force DMSP, COSMIC, Japan GCOM-W1), geostationary orbit (NOAA GOES, Japanese Himawari-8, EUMETSAT Metop, Indian), and Deep Space (DSCOVR). While these satellites are designed for weather and space weather monitoring and forecasting, data and data collection services on these satellites are being used for other applications such as environmental monitoring, search and rescue, and data relay. In addition to space-based data, through the National Centers for Environmental Information, NOAA has access to other data collected by NOAA and foreign observing systems such as, radars, ships, buoys, and aircraft

The recently launched satellites, DSCOVR and Jason-3 have recently been declared operational missions. NOAA's current GOES and polar-orbiting systems are providing data for National Weather Service and the nation's weather enterprise. Next generation satellites, GOES-R will launch on November 4, 2016, and the JPSS-1 satellite will launch no later than 2Q FY 2017. NOAA is making good progress on GOES-S,-T,-U, and the JPSS-2 and Polar Follow On (JPSS-3 and -4). With the Air Force and Taiwan, NOAA is preparing for COSMIC-2A launch in FY 2017. NOAA is assessing how commercial solutions can be used to meet its Global Navigation Satellite System (GNSS) Radio Occultation data with COSMIC-2 capabilities in the polar-orbit.

NESDIS has initiated a comprehensive review of all observing system requirements and capabilities to determine potential challenges and begin identifying possible solutions. The purpose of the NOAA Satellite Observing System Architecture Study is to determine the most cost effective space segment architecture for performing NOAA weather, space weather, and environmental remote sensing missions, beyond the current program of record for operations beginning in the 2030s.

NESDIS recognizes that the commercial sector provides opportunities for meeting space-based weather observations. NOAA has developed a Commercial Space Policy, which details the principles the agency will apply when considering commercial solutions to meet mission requirements. NESDIS is developing the Commercial Space Activities Assessment Process that will guide our engagements with industry as new space systems are defined, developed, and deployed. NESDIS is in the midst of implementing a Commercial Weather Data Pilot and to assess GNSS RO commercial opportunities to meet NOAA's needs.

NOAA intends to leverage data from a global network of systems, including commercial sources, with increasingly capable satellites, models, and processing and distribution systems that provide an ever growing catalog of products, information and services to meet its data requirements

Stephen Volz

Assistant Administrator for Satellite & Information Services
National Oceanic and Atmospheric Administration (NOAA)

Dr. Stephen Volz is the NOAA Assistant Administrator for Satellite and Information Services. NOAA's Satellite and Information Service is dedicated to providing timely access to global environmental data from satellites and other sources to promote, protect and enhance the Nation's economy, security, environment and quality of life. In this role Dr. Volz leads the acquisition and operation of the nation's civil operational environmental satellite system. He also leads efforts for research and development of products and programs to archive and provide access to a variety of Earth observations via three national data centers.

Dr. Volz is a leader in the international Earth observation community, serving as the NOAA Principal to the Committee on Earth Observation Satellites (CEOS). In this capacity he leads efforts to coordinate global satellite-based observations among international space agency partners to further the development of a Global Earth Observation System of Systems. In addition, Dr. Volz serves as the Co-Chair of the NOAA Observing Systems Council, a group that coordinates observing systems requirements and provides resource recommendations for NOAA's observation platforms. He is also a member of the NOAA Executive Council, NOAA's executive decision-making body.

Dr. Volz previously served as the Associate Director for Flight Programs in the Earth Science Division of NASA's Science Mission Directorate. As the Program Director, Dr. Volz managed all of NASA's Earth Science flight missions and associated activities. Within this flight portfolio, Dr. Volz managed a line of Principle Investigator (PI) led missions in airborne science, small satellites, and instrument missions of opportunity, including the development of the Announcements of Opportunity to solicit the science and mission proposals, along with their subsequent evaluation and selection. Steve managed within the flight program a suite of Distributed Active Archive Centers (DAACs) that process, distribute, and archive all of NASA's Earth science data, as well as the science research data products developed from these and other satellite remote-sensing data. Dr. Volz worked with domestic and international space agencies to actively support and promote partnerships and collaboration to further NASA and the nation's Earth science remote-sensing objectives, and to maximize the beneficial utilization of NASA's Earth science data.

Dr. Volz has 26 years professional experience in aerospace. Prior to serving as the Flight Program Director, Dr. Volz was the Earth Science program executive for a series of Earth Science missions, including EO-3 GIFTS, CloudSat, CALIPSO, and ICESat, and he led the Senior Review for the Earth Science operating missions. Dr. Volz worked in industry at Ball Aerospace and Technologies Corporation from 1997–2002, where he was the Project Manager for the Space Infrared Telescope Facility superfluid helium cryostat and other flight projects. From 1986–1997 Dr. Volz worked for NASA's Goddard Space Flight Center as an instrument manager, an I&T Manager, a systems engineer, and a cryogenic systems engineer on missions and instruments including the Cosmic Background Explorer (COBE), among others.

Dr. Volz is a member of several professional societies, including the American Physical Society (M'82), the American Astronomical Society (M'87), the American Geophysical Union (M'02), and the American Meteorological

Society (M'08). He is a senior member of the Institute of Electrical and Electronics Engineers (IEEE), an active member of and participant in the Geoscience and Remote Sensing Society (GRSS), and a member of the GRSS Administration Committee (AdCom) for the period of 2013–2017. He is the recipient of several awards, including the Silver Snoopy Award from NASA's astronaut team in 1994 for his work as the instrument manager and team lead for the Space Shuttle cross bay mounted Superfluid Helium On Orbit Transfer (SHOOT) experiment, the Goddard Space Flight Center John Boeckel Award for Engineering Excellence (1992), and the Ball Corporation Award of Excellence from the Ball Aerospace and Technology Corporation (BATC) in 2001.

Dr. Volz has a doctorate in Experimental Condensed Matter Physics from the University of Illinois at Urbana-Champaign (1986), a master's in Physics from Illinois (1981), and a bachelor's in Physics from the University of Virginia (1980). He has more than 20 publications in peer-reviewed journals.

Dr. Volz is a native-born Washingtonian, and lives in Bethesda with his wife Beth and his two teenage daughters.

Chairman BRIDENSTINE. Thank you for your testimony.
Mr. Powner, you're recognized for five minutes.

TESTIMONY OF MR. DAVID POWNER, DIRECTOR, INFORMATION TECHNOLOGY MANAGEMENT ISSUES, GOVERNMENT ACCOUNTABILITY OFFICE

Mr. POWNER. Chairman Bridenstine, Ranking Member Johnson, and Members of the Subcommittee, since my December testimony before this subcommittee, we have continued to review the JPSS program and NOAA's policies and procedures for determining the life span of existing and future satellites. Accurately depicting these life spans is important, given potential gaps in coverage and the timing of the out-year satellite acquisitions.

This morning, I will provide an update on the JPSS program, the latest of our estimate on the potential gap, a security assessment of the ground stations, and some observations about the Polar Follow-On program.

JPSS's launch date of March 2017 is on target according to NOAA despite the program missing interim milestones for the spacecraft, ATMS, and the ground segment. This is the case since the program had sufficient costs and schedule reserves built into it. This committee's persistent questioning of these reserves over the past several years demonstrates the important role your consistent oversight has played.

We still remain concerned about the launch date because the launch readiness date just slipped one month from December 2016 to January 2017. Two key areas to watch are the August ground station delivery and the upcoming thermal vac test, which is to start at the end of this month.

So with the March 2017 launch date and a three month checkout period, which is somewhat optimistic, JPSS–1 is expected to be the primary operational satellite in the early afternoon orbit around June 2017 or roughly a year from now.

I'd like to display a chart that I showed at the December hearing.

[Slide.]

At that hearing I testified and NOAA agreed that it was extending the NPP life span from October 2016 to 2020. That's the red arrow at the top of the chart. At that time, we questioned whether it should be extended the full four years given NOAA's assessment. Since then, we've learned that NOAA now labels this four-year extension as fuel-limited life, and it is not the expected life of the spacecraft and sensors. This is just another instance where NOAA's charts and satellite life spans have been misleading to the Congress.

Another key question is whether the ATMS instrument on NPP will last until J–1's ATMS becomes operational. We testified in December about the ATMS issues, and they continue.

Just recently, we made recommendations to NOAA to develop a policy for updating its fly-out charts to include having these life spans consistently and accurately reported based on detailed analyses. We believe this rigor in developing the fly-out charts is critical for NOAA to rebuild trust with both this committee and with the appropriation committees.

Mr. Chairman, I'd now like to turn to the ground station security findings and recommendations. This is an important area because NOAA has reported several incidents regarding access to its ground system, including hostile probes and unauthorized access. To its credit, NOAA has a systems security plan, has performed detailed penetration tests, and is working to address known vulnerabilities. However, NOAA has determined that the JPSS ground system is at high risk of compromise due to the significant number of controls that are not fully implemented.

[Slide.]

As this next chart displays, NOAA has been working on over 1,000 critical and high vulnerabilities on the current ground station and hundreds more have been identified from penetration tests on the ground upgrade. Just last night, NOAA provided an update on open vulnerabilities and they report decreasing roughly 1,500 open critical and high vulnerabilities down to about 1,200, a decrease of 300. Of concern are the critical vulnerabilities associated with the current operational ground station. These actually increased slightly. No one needs to close these vulnerabilities much quicker. Some areas to address these vulnerabilities include applying recommended patches and implementing stronger access controls.

Turning to the follow-on program, we are all for robust constellations and avoiding any potential gaps like the one we hope does not occur between NPP and J–1, but proposals to build J–3 and 4 to store nearly 3 and six years respectively need to be supported by cost-benefit analyses of different storage and launch scenarios. In addition, these continuity decisions need to be balanced with minimizing program costs.

In conclusion, NOAA has done a solid job coming out of the NPOESS debacle and being on the verge of the J–1 launch. Monitoring the remaining tests in the ground station delivery is important in these remaining months to see if the March 2017 launch date holds.

Regarding the gap between NPP and J–1, ATMS aware is the critical watch list item. NOAA also needs to more accurately inform Congress of satellite life spans and potential gaps in coverage, and finally, they need to better secure ground stations to avoid security incidents involving the loss of critical weather data.

This concludes my statement. I look forward to your questions.

[The prepared statement of Mr. Powner follows:]

United States Government Accountability Office

Testimony

Before the Subcommittee on Environment, Committee on Science, Space, and Technology, House of Representatives

For Release on Delivery
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POLAR SATELLITES

NOAA Faces Challenges and Uncertainties that Could Affect the Availability of Critical Weather Data

Statement of David A. Powner
Director, Information Technology Management Issues

GAO Highlights

Highlights of GAO-16-773T, a testimony before the Subcommittee on Environment, Committee on Science, Space, and Technology, House of Representatives

Why GAO Did This Study

Polar-orbiting satellites provide data that are essential to support weather observations and forecasts. NOAA is preparing to launch the second satellite in the JPSS program in March 2017, but a near-term gap in polar satellite coverage remains likely. Given the criticality of satellite data to weather forecasts and the potential impact of a satellite data gap, GAO added this area to its High-Risk List in 2013.

This statement addresses the status of the JPSS program and plans for future satellites, NOAA's efforts to depict and update satellite timelines, and the JPSS program's implementation of key information security protections. This statement is based on a May 2016 report on JPSS and a draft report on satellite timelines. To develop the draft report, GAO reviewed agency procedures for updating satellite timelines, compared timelines to best practices and agency documentation, and interviewed officials.

What GAO Recommends

In its May 2016 report, GAO recommended that NOAA assess the costs and benefits of different launch decisions based on updated satellite life expectancies, and address deficiencies in its information security program. NOAA concurred with these recommendations. GAO's draft report includes recommendations to NOAA to improve the accuracy, consistency, and documentation supporting updates to satellite timelines, and to revise and finalize its draft policy governing timeline updates. This report is currently at the Department of Commerce for comment.

View GAO-16-773T. For more information, contact David A. Powner at (202) 512-9286 or pownerd@gao.gov

July 7, 2016

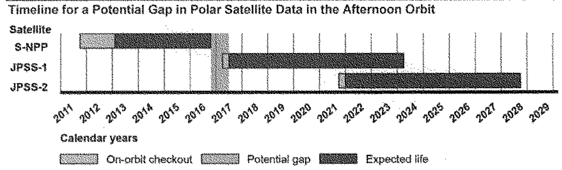
POLAR SATELLITES

NOAA Faces Challenges and Uncertainties that Could Affect the Availability of Critical Weather Data

What GAO Found

As highlighted in a May 2016 report, the National Oceanic and Atmospheric Administration's (NOAA) Joint Polar Satellite System (JPSS) program has continued to make progress in developing the JPSS-1 satellite for a March 2017 launch. However, the program has experienced technical challenges which have resulted in delays in interim milestones. In addition, NOAA faces the potential for a near-term gap in satellite coverage of 8 months before the JPSS-1 satellite is launched and completes post-launch testing (see figure). NOAA has also begun planning for future polar satellites. However, uncertainties remained on the best timing for launching these satellites, in part because of the potential for some satellites already in orbit to last longer. NOAA did not provide sufficient evidence that it had evaluated the costs and benefits of launch scenarios for these new satellites based on updated life expectancies. Until this occurs, NOAA may not make the most efficient use of investments in the polar satellite program.

Timeline for a Potential Gap in Polar Satellite Data in the Afternoon Orbit



Source: GAO analysis based on National Oceanic and Atmospheric Administration and National Aeronautics and Space Administration data. | GAO-16-773T

Note: The afternoon orbit is one of three primary polar orbits providing needed coverage for numerical weather models.

As noted in a draft GAO report, NOAA publishes "flyout charts" depicting satellite timelines to support budget requests and appropriations discussions. The agency regularly updates its charts when key changes occur. However, the charts do not always accurately reflect data from other program documentation such as the latest satellite schedules or assessments of satellite availability. NOAA also has not consistently documented its justification for chart updates or depicted lifetimes for satellites beyond their design life, and has not finalized a policy for updating its charts. As a result, the information NOAA provides Congress on the flyout charts is not as accurate as it needs to be, which could result in less-than-optimal decisions.

GAO reported in May 2016 that, although NOAA has established information security policies in key areas recommended by guidance, the JPSS program has not yet fully implemented them. Specifically, while the program has implemented multiple relevant security controls, it has not yet fully implemented almost half of the recommended security controls, did not have all of the information it needed when assessing security controls, and has not addressed key vulnerabilities in a timely manner. Furthermore, NOAA has experienced 10 key information security incidents related to the JPSS ground system, including incidents regarding unauthorized access to web servers and computers. Until NOAA addresses these weaknesses, the JPSS ground system remains at high risk of compromise.

Chairman Bridenstine, Ranking Member Bonamici, and Members of the Subcommittee:

Thank you for the opportunity to participate in today's hearing on an important satellite acquisition program within the Department of Commerce's National Oceanic and Atmospheric Administration (NOAA). In 2010, NOAA initiated the Joint Polar Satellite System (JPSS) program with assistance from the National Aeronautics and Space Administration (NASA). NOAA launched the first satellite in the JPSS program in October 2011, and plans to launch the next satellite by March 2017. NOAA also plans to launch other similar satellites in the future.

The JPSS program is critical to the United States' ability to maintain the continuity of data required for weather forecasting. According to officials at NOAA, a gap in polar satellite data would result in less accurate and timely weather forecasts and warnings of extreme events, such as hurricanes, storm surges, and floods. Such degradation in forecasts and warnings would place lives, property, and our nation's critical infrastructures in danger. Given the criticality of satellite data to weather forecasts, the possibility of a satellite data gap, and the potential impact of a gap, we added this area to our High-Risk List in 2013 and it remained on the High-Risk List in 2015.[1]

This statement summarizes a recently issued report and key findings from a draft report on (1) the status of the JPSS program and plans for future satellites, (2) NOAA's efforts to depict and update satellite timelines; and (3) the JPSS program's implementation of key information security protections. Specifically, this statement is based on a May 2016 report detailing NOAA's progress on the JPSS satellite program with respect to schedule and key risks, its efforts to plan and implement a follow-on polar satellite program, and the JPSS program's implementation of key information security protections.[2] More detailed information on our objectives, scope, and methodology can be found in the issued report.

[1]Every 2 years, at the start of a new Congress, we call attention to agencies and program areas that are high risk due to their vulnerabilities to fraud, waste, abuse, and mismanagement, or are most in need of transformation. See GAO, *High Risk Series: An Update*, GAO-13-283 (Washington, D.C.: Feb. 14, 2013) and *High Risk Series: An Update*, GAO-15-290 (Washington, D.C.: Feb. 11, 2015).

[2]GAO, *Polar Weather Satellites: NOAA Is Working to Ensure Continuity but Needs to Quickly Address Information Security Weaknesses and Future Program Uncertainties*, GAO-16-359 (Washington, D.C.: May 17, 2016).

This statement is also based on a draft report that includes the results of work we performed for the House Committee on Appropriations for information on NOAA's efforts to depict and update polar satellite timeline information. For our draft report, we reviewed NOAA policies, procedures, and documentation on recent updates to it satellite timelines, compared the timeline updates to other agency documentation and support materials, and interviewed agency officials. We reviewed information from the draft report with agency officials and made technical changes as appropriate. This draft report is currently at the Department of Commerce for official comment. We expect to issue the report by September 2016.

The work upon which this statement was based was conducted in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

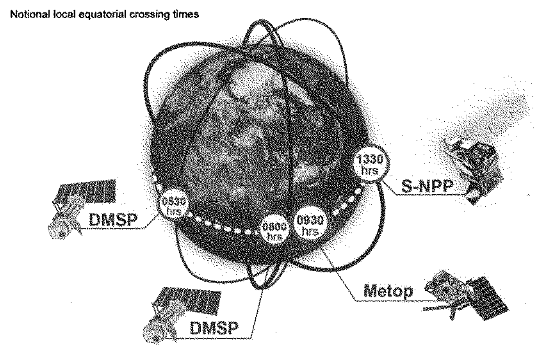
Background

Since the 1960s, the United States has operated polar-orbiting satellite systems that obtain environmental data to support weather observations and forecasts. These data are processed to provide graphical weather images and specialized weather products. Data from polar satellites are also the predominant input to numerical weather prediction models, which are a primary tool for forecasting weather days in advance—including forecasting the path and intensity of hurricanes. These weather products and models are used to predict the potential impact of severe weather so that communities and emergency managers can help prevent and mitigate its effects.

Polar-orbiting satellites circle the earth in a nearly north-south orbit, providing global observation of conditions that affect the weather and climate. Each satellite makes about 14 orbits a day. As the earth rotates beneath it, each polar-orbiting satellite views the entire earth's surface twice a day.

Currently, the polar-orbiting satellites that are considered primary satellites for providing input to weather forecasting models are a NOAA/NASA satellite (called Suomi National Polar-orbiting Partnership, or S-NPP), two Department of Defense (DOD) satellites, and a series of European satellites. These satellites cross the equator in early morning, mid-morning, and early afternoon orbits, with S-NPP in the early afternoon orbit. NOAA, the Air Force, and a European weather satellite organization also maintain older satellites that provide limited backup to these operational satellites. Figure 1 illustrates the current operational polar satellite constellation.

Figure 1: Configuration of Operational Polar Satellites



Sources: GAO, based on NPOESS Integrated Program Office, National Oceanic and Atmospheric Administration, and Department of Defense data; National Aeronautics and Space Administration/Goddard Space Flight Center Scientific Visualization Studio (earth); S-NPP image provided courtesy of University of Wisconsin-Madison Space Science and Engineering Center. | GAO-16-773T

Note: DMSP – Defense Meteorological Satellite Program; Metop – Meteorological Operational; S-NPP – Suomi National Polar-orbiting Partnership.

According to NOAA, 80 percent of the data assimilated into its National Weather Service numerical weather prediction models that are used to produce weather forecasts 3 days and beyond is provided by polar-orbiting satellites. Specifically, a single afternoon polar satellite provides NOAA 45 percent of the global coverage it needs for its numerical weather models. NOAA obtains the rest of the polar satellite data it needs from other satellite programs, including DOD's early morning satellites and the European mid-morning satellite.

Overview of JPSS Program

NOAA is currently executing a major satellite acquisition program to replace existing polar satellite systems that are nearing the end of their expected life spans. NOAA established the JPSS program in 2010 after a prior tri-agency program was disbanded due to technical and management challenges, cost growth, and schedule delays.[3] The JPSS program guided the development and launch of the Suomi-National Polar-orbiting Partnership (S-NPP) satellite in 2011[4] and is responsible for two other planned JPSS satellites, known as JPSS-1 and JPSS-2. The current anticipated launch dates for these two satellites are March 2017 and December 2021, respectively. More recently, NOAA has also begun planning the Polar Follow-On program, which is to include the development and launch of a third and fourth satellite in the series in July 2026 and July 2031, respectively. These are planned to be nearly identical to the JPSS-2 satellite.

NOAA has organized the JPSS program into flight and ground projects that have separate areas of responsibility. The flight project includes a set of five instruments, the spacecraft, and launch services. The ground project consists of ground-based systems that handle satellite communications and data processing. The ground system's versions are numbered; the version that is currently in use is called Block 1.2, and the new version that is under development is called Block 2.0. Among other things, Block 2.0 is to enable the JPSS ground system to support both the S-NPP and all planned JPSS satellites.

Since 2012, we have issued reports on the JPSS program that highlighted technical issues, component cost growth, management challenges, and key risks.[5] In these reports, we made 15 recommendations to NOAA to improve the management of the JPSS program. These recommendations included addressing key risks, establishing a comprehensive contingency plan consistent with best practices, and addressing weaknesses in information security practices.

[3]The National Polar-orbiting Operational Environmental Satellite System was a tri-agency program made up of NOAA, the Department of Defense, and NASA. It was disbanded in 2010.

[4]S-NPP was originally planned as a demonstration satellite, but due to schedule delays that had the potential to lead to satellite data gaps, NOAA made the decision to use it as an operational satellite. This means that the satellite's data are used for climate and weather products.

[5]See GAO-16-359; *Polar Weather Satellites: NOAA Needs To Prepare for Near-term Data Gaps*, GAO-15-47 (Washington, D.C.: Dec. 16, 2014); *Polar Weather Satellites: NOAA Identified Ways to Mitigate Data Gaps, but Contingency Plans and Schedules Require Further Attention*, GAO-13-676 (Washington, D.C.: Sept. 11, 2013); and *Polar-Orbiting Environmental Satellites: Changing Requirements, Technical Issues, and Looming Data Gaps Require Focused Attention,* GAO-12-604 (Washington, D.C.: June 15, 2012).

As we reported in May 2016, the agency had implemented 2 recommendations and was working to address the remainder. In particular, NOAA established contingency plans to mitigate the possibility of a polar satellite data gap and began tracking completion dates for its gap mitigation activities. NOAA has also taken steps such as performing a new schedule risk analysis, and adding information on the impact of space debris to its annual assessment of satellite availability. We have ongoing work reviewing the agency's progress in implementing these open recommendations.

NOAA Continues to Develop JPSS Satellites, but Faces Remaining Challenges and Uncertainties Regarding Future Decisions

Over the past year, the JPSS program has made progress in developing the JPSS-1 satellite, but continues to face challenges as it approaches the early 2017 launch date. The program completed all instruments on the JPSS-1 satellite and integrated them on the spacecraft by early 2016. As of December 2015, the JPSS program reported that it remained on track to meet its committed launch date of March 2017.

However, as highlighted in our May 2016 report, the JPSS program continues to face challenges as it approaches the early 2017 launch date.[6] Specifically, the JPSS program had experienced delays ranging from 3 to 10 months on key components since mid-2014, as well as technical challenges on both the flight and ground systems. For example, the program recently experienced multiple issues in completing a component on the spacecraft, called a gimbal,[7] which moved the component's planned completion date forward by almost a year before it was completed in March 2016. These issues in turn delayed the beginning of the JPSS-1 satellite's environmental testing. The gimbal issue also was a factor in the program choosing to move back its launch readiness date—the date that the JPSS-1 satellite is planned to be ready for launch—from December 2016 to January 2017.

Regarding the JPSS ground system, the program experienced an unexpectedly high number of program trouble reports in completing the

[6]See GAO-16-359.

[7]A gimbal provides articulation for selected antennas responsible for transmitting stored data to communication satellites and ground systems.

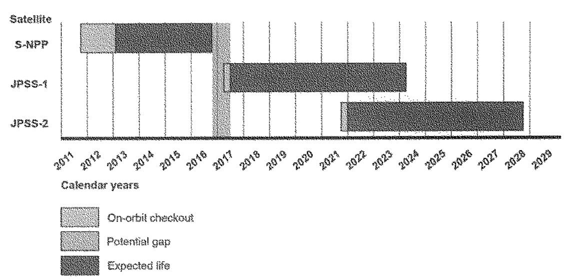
upgrade to block 2.0, which is needed for security and requirements improvements in tandem with the JPSS-1 satellite's launch. A key milestone related to this upgrade was recently delayed from January to August 2016.

While NOAA satellite timelines show continuous coverage in the afternoon orbit, the JPSS program still faces the potential for a near-term gap in satellite coverage. As we reported in May 2016, NOAA had increased the estimated useful life for S-NPP by up to 4 years. Under this new scenario, a near-term gap in satellite data would not be expected because S-NPP would last longer than the expected start of operations for JPSS-1.

However, subsequent NOAA documentation showed this 4-year period as "fuel limited life." NOAA officials explained that this extended period is based on expected fuel availability, and does not take into account the likelihood that the instruments and spacecraft will fail before the satellite runs out of fuel. In other words, the extended useful life depicts the satellite's maximum possible life, not its expected life.

As a result, the JPSS program continues to face a potential gap of 8 months between the end of S-NPP's expected life in October 2016, and when the JPSS-1 satellite is launched and completes post-launch testing in June 2017. Figure 2 shows the potential gap period.

Figure 2: Timeline for a Potential Gap in Polar Satellite Data in the Afternoon Orbit



Source: GAO analysis based on National Oceanic and Atmospheric Administration and National Aeronautics and Space Administration data. | GAO-16-773T

Note: The afternoon orbit is one of three primary polar orbits. A single afternoon polar satellite provides NOAA 45 percent of the global coverage it needs for its numerical weather models.

The June 2017 completion date also assumes a 3 month period for the JPSS-1 satellite's on-orbit checkout. However, based on on-orbit checkout periods from past polar satellites, it is likely that checkout could take longer than this, potentially lengthening the gap. As a precedent, it took the JPSS program about 2 years to fully validate the highest-priority data products from the S-NPP satellite. If S-NPP unexpectedly fails sooner, or the JPSS-1 launch date is delayed, a longer gap could result.

Uncertainties Remain on Key Future JPSS Development Dates

In addition to its work in completing the JPSS-1 satellite, NOAA has begun planning for new satellites to ensure the future continuity of polar satellite data. In a new program, called the Polar Follow-On (PFO), NOAA plans to build two new satellites, JPSS-3 and JPSS-4, that are copies of the JPSS-2 satellite. Like JPSS-2, these satellites are to include all three key performance parameter instruments, as well as a fourth environmental sensor. NOAA plans to complete development of JPSS-3 and JPSS-4 several years ahead of their planned launch date. In the nearer term, NOAA plans to build a smaller satellite that can provide a replacement for some data produced by one of the most essential JPSS instruments.

NOAA's decisions on what PFO will include are based on what the agency calls a robust constellation: creating a situation where it would take two failures to create a gap on data from key instruments, and where the agency would be able to restore full coverage in a year in the event of a failure.

We reported in May 2016 that NOAA has taken several steps in planning the PFO program, including establishing goal launch dates and high-level budget estimates. However, it had not completed formulation documents such as high-level requirements, a project plan, or budget information for key components.

In addition, uncertainties remain about whether early development of JPSS-3 and JPSS-4 is necessary to achieve robustness. For instance, in its initial calendar for PFO, NOAA considered lifetimes of 10 years or more for the JPSS-1 and JPSS-2 satellites, while NOAA charts used for budget justification continue to show only 7 year lifetimes. If satellites are likely to last longer than expected, there could be unnecessary redundancy in coverage. Until NOAA ensures that its plans for future polar satellite development are based on the full range of estimated lives of potential satellites, the agency may not be making the most efficient use of the nation's sizable investment in the polar satellite program.

As a result of this uncertainty, we recommended that NOAA evaluate the costs and benefits of different launch scenarios for the JPSS PFO program, based on updated satellite life expectancies, to ensure satellite continuity while minimizing program costs. NOAA concurred and noted that it had evaluated the costs and benefits of different launch scenarios using the latest estimates of satellite lives as part of its budget submission. However, the agency did not provide sufficient supporting evidence or artifacts showing that it had evaluated costs and benefits of launch scenarios in this way.

NOAA's Timelines for Current and Future NOAA Polar Satellites Are Not Consistently Accurate and Useful

NOAA's National Environmental Satellite Data and Information Service (NESDIS), regularly publishes "flyout charts" for its satellites which depict timelines for the launch, on-orbit storage, and operational life of its satellites. Among other things, NOAA uses these charts to support budget requests, alert users when new satellites will be operational, and keep the public informed on plans to maintain satellite continuity.

In a draft report currently at the Department of Commerce for comment, we reported that NOAA has updated its polar flyout charts three times in the last 2-and-a-half years. Key changes that can result in an update include adding newly planned satellites; removing a satellite that has reached the end of its life; and adjusting planned dates for when satellites are to launch, begin operations, or reach the end of their useful lives. Among the data NOAA uses in updating its charts are health status information of operational satellites, planned schedules for new satellites, and analysis from operational satellite experts.

However, while NOAA regularly updates its charts and most of the data on them were aligned with other program documentation, the agency has not consistently ensured that its charts were accurate, supported by stringent analysis, and fully documented. Specifically:

- The charts were at times inconsistent with other program data. For example, in one out of 10 available instances for comparison, flyout chart data did not match underlying program data. JPSS program data as of April 2015 listed the JPSS-2 satellite launch as November 2021, but the flyout chart from that month showed it 4 months earlier, in July 2021.

The flyout charts also inconsistently reflected data from annual satellite availability assessments performed by the JPSS program. In addition, weaknesses remained in the latest annual availability assessment from 2015. For example, NOAA assumed that JPSS-1 data from key instruments will be available to users 3 months after launch. However, based on on-orbit checkout periods from past polar satellites, it is likely that checkout could take much longer than this, potentially lengthening the gap.

- NOAA did not consistently document the justification for updates to its polar satellite flyout charts. For example, the NOAA department responsible for providing summary packages for each flyout chart update provided justification for the key changes in only one of three documentation packages. Furthermore, standard summary documents, such as a routing list and information on the disposition of comments, were included for only one of the three documentation packages for polar flyout charts.
- NOAA also does not consistently depict how long a satellite might last once it is beyond its design life. For instance, NESDIS, the NOAA entity responsible for satellite operations, recently added a 4-year extension to the useful life of the S-NPP satellite. This extension was meant to depict maximum potential life, assuming all instruments and the spacecraft continue functioning. However, the agency did not clearly define this term on its charts, thereby allowing readers to assume the agency expects the satellites to last through the end of the fuel-limited life period.

  Also, as stated above, in its justification for funding for the Polar Follow-on (PFO) program, NOAA considered lifetimes for JPSS-1 and JPSS-2 to be longer by several years when compared to the lifetimes listed on its flyout charts. Program officials indicated that the estimates they develop prior to a satellite's launch are more conservative due to greater uncertainty at that stage. However, inconsistencies such as these have the effect of implying that some satellites will reach their end-of-life sooner or later than the agency anticipates.

Part of the reason for these process shortfalls is that NOAA has not finalized a policy with standard steps to follow when making chart updates. Consequently, the information that NOAA provides Congress on the flyout charts is not as accurate as it needs to be, which could result in less-than-optimal decisions. Furthermore, lack of communication of the potential ambiguities inherent in changes to satellite lifetimes could have major effects on future decision-making.

To address these weaknesses, our draft report includes a series of recommendations to NOAA, including requiring satellite programs to perform regular assessments of satellite availability, implementing a consistent approach to depicting satellites beyond their design lives, and revising and finalizing the policy for updating flyout charts.

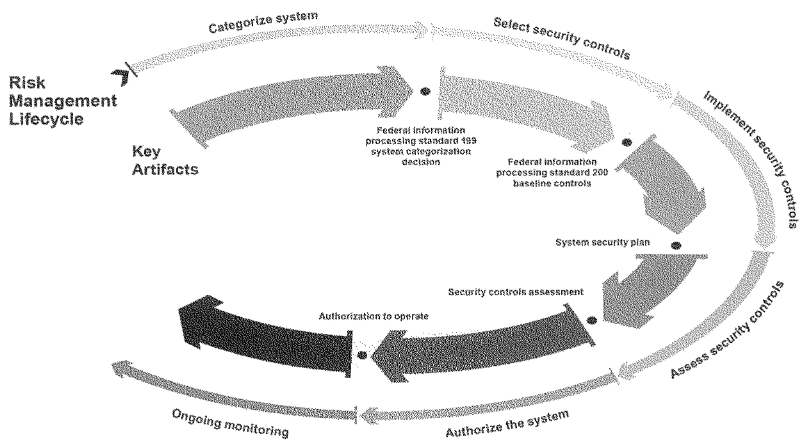
The JPSS Program Needs to Address Critical Information Security Weaknesses

Safeguarding federal computer systems and systems supporting national infrastructure is essential to protecting public health and safety. Federal law and guidance specify requirements for protecting federal information and information systems. In particular, the Federal Information Security Modernization Act of 2014 (FISMA) requires executive branch agencies to develop, document, and implement an agency-wide information security program.

FISMA also requires the National Institute of Standards and Technology (NIST)[8] to develop standards and guidelines for agencies to use in categorizing their information systems and minimum requirements for each category. Accordingly, NIST developed a risk management framework of standards and guidelines to follow in developing information security programs. Figure 3 shows an overview of the steps in this framework, including components of the risk management lifecycle as well as key activities and artifacts.

[8] The Federal Information Security Modernization Act of 2014, Pub. L. No. 113-283, 128 Stat. 3073 (Dec. 18, 2014), largely supersedes the very similar Federal Information Security Management Act of 2002, Pub. L. No. 107-347, 116 Stat. 2899, 2946 (Dec. 17, 2002). The 2002 act's requirements that the National Institute of Standards and Technology establish standards and guidance for implementation of the act were not superseded and continue to apply.

Figure 3: Overview of the National Institute of Standards and Technology's Risk Management Framework for an Information Security Program



Sources: GAO and National Institute of Standards and Technology. | GAO-16-773T

As we reported in May 2016, NOAA had established information security policies in key areas detailed by FISMA and recommended by NIST guidance and the JPSS program had made progress in implementing these policies.[9] However, we found that the program had weaknesses in several areas related to its ground system which, if not addressed, could put the JPSS ground system at high risk of compromise.

- **Key controls not fully implemented.** The JPSS program, using NIST guidance on system categorization, identified its ground system as a high-impact system, meaning that a loss of confidentiality, integrity, or availability could be expected to have a catastrophic effect on operations, and identified needed security controls based on this classification. However, the program had fully implemented only 53

[9] GAO-16-359.

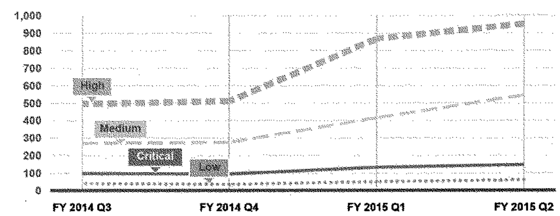
percent of required security controls, and had fully implemented controls in only one area.

- **Limitations in Controls Assessment.** The program developed an assessment plan to identify weaknesses in the controls established by the program, and implemented the assessment. However, the assessment had significant limitations, including inconsistencies in maintaining a valid inventory, uncertainty about the physical locations for program components, and a discrepancy between the inventory used for testing and the actual live inventory of the program's systems.

- **Delay in Fixing Critical Weaknesses.** In accordance with NOAA policy, the program established plans of action and milestones to address control weaknesses in both the current and future version of its ground system, and had made progress in addressing many of its security weaknesses through this process. However, many vulnerabilities remain unaddressed because the program did not comply with Department of Commerce policy to remediate critical and high-risk vulnerabilities within 30 days.

  As of its 2015 assessment of program controls, the JPSS program had 146 critical and 951 high risk vulnerabilities on the current iteration of the ground system, and 102 critical and 295 high risk vulnerabilities on the next iteration of the ground system. Vulnerabilities remaining open include instances of outdated software, an obsolete web server, as well as more than 200 instances of use of outdated definitions used to scan and identify viruses. Figure 4 graphically shows the number of open vulnerabilities on the current JPSS ground system over time.

Figure 4: Open Vulnerabilities Identified on the Current Joint Polar Satellite System's Ground System



Source: GAO, based on National Oceanic and Atmospheric Administration data. | GAO-16-773T

Note: NOAA identifies vulnerabilities as critical, high, medium, and low risk. Critical and high risk vulnerabilities pose an increased risk of compromise.

Without addressing these vulnerabilities in a timely manner, the program remains at increased risk of potential exploits.

- **Security Incidents Report but Not Consistently Tracked.** In accordance with NOAA policy, the JPSS program established a continuous monitoring plan to track security incidents and intrusions and to ensure that information security controls are working. Specifically, NOAA officials reported 10 medium and high severity incidents related to the JPSS ground system, including incidents involving unauthorized access to web servers and computers, between August 2014 and August 2015. Of these, NOAA closed 6 incidents involving hostile probes, improper usage, unauthorized access, password sharing, and other IT-related security concerns.

  However, the agency did not consistently track all incidents. Specifically, there were differences between what is being tracked by the JPSS program, and what is closed by NOAA's incident response team. For example, 2 of the 4 incidents that were recommended for closure by the JPSS program office are currently still open according to the incident report. Until NOAA and the JPSS program have a consistent understanding of the status of incidents, there is an increased risk that key vulnerabilities will not be identified or properly addressed.

To address these deficiencies, we recommended in our May 2016 report that the Secretary of Commerce direct the Administrator of NOAA to establish a plan to address the limitations in the program's efforts to test security controls, including ensuring that (1) any changes in the system's inventory do not materially affect test results; (2) critical and high-risk vulnerabilities are addressed within 30 days, as required by agency policy; and (3) the agency and program are tracking and closing a consistent set of incident response activities.

NOAA concurred with our recommendations. Regarding critical and high-risk vulnerabilities, NOAA noted that the JPSS program would continue to follow agency policy allowing its authorizing official to accept risks when remediation cannot be performed as anticipated. However, the program did not have documentation from the authorizing official accepting the risk of a delayed remediation schedule for critical and high-risk vulnerabilities.

In summary, NOAA is making progress in developing and testing the JPSS-1 satellite as it moves toward a March 2017 launch date, but continues to experience issues in remaining ground system development, and faces a potential near-term data gap in the period before this satellite becomes operational. In addition, NOAA is planning to launch a future set of satellites to ensure continuity of future satellite data, but it is uncertain which launch timing will best meet the agency's criteria for a robust constellation. Without ensuring that its plans for future satellite development are based on the full range of estimated lives of potential satellites, the agency may not be making the most efficient use of the nation's sizable investment in the polar satellite program.

Further, findings from a draft report show that NOAA's efforts to depict and update key polar satellite information, such as timelines and operational life, need to be improved. Its flyout charts, used to inform users of potential gaps and support budget requests, did not always accurately reflect current program data or consistently present key information, such as a satellite's lifetime once beyond its original design life. This is in part because NOAA has not finalized a policy that includes standard steps for updating its charts. Until NOAA addresses these shortfalls, it runs an increased risk that its flyout charts will mislead Congress and may lead to less-than-optimal decisions.

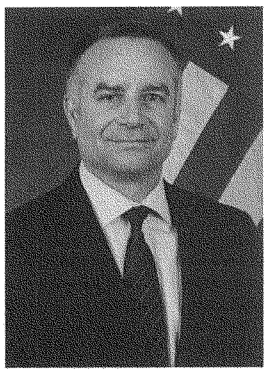
As a part of JPSS ground system development, NOAA has established policies in key information security areas called for by guidance. However, the program has not fully implemented the policy in several areas. For example, the program fully implemented just over half of its required security controls, a recent security assessment itself had significant limitations, and the program has not remediated critical and high-risk vulnerabilities in a timely manner. Until NOAA addresses these weaknesses, the JPSS ground system remains at high risk of compromise.

Chairman Bridenstine, Ranking Member Bonamici, and Members of the Subcommittee, this completes my prepared statement. I would be pleased to respond to any questions that you may have at this time.

GAO Contacts and Staff Acknowledgments

If you have any questions on matters discussed in this testimony, please contact David A. Powner at (202) 512-9286 or at pownerd@gao.gov. Other contributors include Colleen Phillips (Assistant Director), Shaun Byrnes (Analyst-in-Charge), Christopher Businsky, Torrey Hardee, Lee McCracken, and Umesh Thakkar.

Biography



David A. Powner is the Director of Information Technology Management Issues at the U.S. Government Accountability Office (GAO). Dave has more than twenty-five years' experience in both the public and private sectors.

Dave is currently responsible for a large segment of GAO's information technology work that focuses on large-scale system acquisitions, IT governance, operational systems management, and various IT reform initiatives (e.g., IT Dashboard, data center consolidation, portfolio management, cloud computing).

In the private sector, Dave held several executive-level positions in the telecommunications industry including overseeing IT and financial internal audits and software development associated with high speed internet systems.

At GAO, he has led teams reviewing major modernization efforts at Cheyenne Mountain Air Force Station, the National Weather Service, the Federal Aviation Administration, and the Internal Revenue Service. He has also led GAO's work on weather satellite acquisitions, cyber critical infrastructure protection, and health IT.

Dave has testified before Congress more than 80 times over the past several years. These and other GAO products have led to billions of dollars in taxpayer savings and improvements to a wide range of IT acquisitions and operations. Dave has received several GAO awards for his work, including several associated with Congressional service. Outside of GAO, he received Federal Computer Week's Federal 100 award in 2008 and again in 2012.

Dave holds a bachelor's degree in business administration from the University of Denver and attended the Senior Executive Fellows Program at the John F. Kennedy School of Government at Harvard University.

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Chairman BRIDENSTINE. I'd like to thank the gentleman.

Mr. Stoffler, you're recognized for five minutes for an opening statement.

TESTIMONY OF MR. RALPH STOFFLER, DIRECTOR OF WEATHER, DEPUTY CHIEF OF STAFF FOR OPERATIONS, U.S. AIR FORCE

Mr. STOFFLER. Chairman Bridenstine, Ranking Member Bonamici, and Members of the Subcommittee, thank you for the opportunity to appear before you——

Chairman BRIDENSTINE. Would the gentleman yield for one second? Can you move your microphone to be in front of you? All right. Good.

Mr. STOFFLER. Let me start again then. Chairman Bridenstine, Ranking Member Bonamici, and members of the subcommittee, thank you for the opportunity to appear before you this morning to discuss space-based environmental monitoring and the partnerships that ensure accurate and timely forecast capabilities.

Air Force weather is comprised of people, systems, and processes that together deliver unique services to the joint war fighter United States Air Force and the United States Army. Air Force's weather primary mission is centered on analyzing and forecasting global weather and solar impacts on military and combat operations. We strive to minimize the impact of weather threats to friendly forces while simultaneously capitalizing on weather conditions that maximize the operational advantage over enemy forces and exploit enemy weaknesses.

We achieve our mission with total force airmen, uniformed and civil servants around the world, educated and trained on space and weather impacts to the war fighting mission. Our airmen serve in capacities requiring combat field skills, move-shoot communicate skills, combat lifesaver qualifications, and Army airborne and special operations parachutist competencies. We develop theater weather-sensing strategies for each operation and leverage all appropriate available data sets. We minimize data gaps by deploying Air Force tactical weather centers and incorporating data from nontraditional weather sources to develop the environmental picture of the battle space.

We achieve this through cooperative engagements with our coalition partners, military-to-military engagements, national and international cooperation, and Department of Defense unique programs. We analyze and assimilate this data into our operational centers and our numerical models to present a unified forecast to the coalition war fighting team for multiple security classification levels.

The war fighter receives a timely and consistent battle space weather picture in the planning and execution phases of an operation that addresses strategic operational and tactical needs.

In the post-combat portion of operations, we work to normalize the impact to nations by training personnel and restoring basic meteorological services, which allows the Department of Defense to withdraw its resources to be ready for the next engagement.

Fundamental to nearly all military operations and all levels of the military decision-making process is the information and data provided by weather satellites. We fully recognize that the American private sector can provide technological advances and research in the science of our craft to provide an essential element to our weather enterprise. While this progress is exciting, we must balance our portfolio with constraints in human capital, physical means, and prioritization to ensure our future capabilities directly correlate to the combat commanders' war fighting needs.

Thank you again for the opportunity and privilege to testify before you today. I'm happy to answer any questions you may have.

[The prepared statement of Mr. Stoffler follows:]

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SUBCOMMITTEE ON THE ENVIRONMENT
SPACE, SCIENCE, AND TECHNOLOGY COMMITTEE
UNITED STATES HOUSE OF REPRESENTATIVES

DEPARTMENT OF THE AIR FORCE

SUBCOMMITTEE ON THE ENVIRONMENT
SPACE, SCIENCE, AND TECHNOLOGY COMMITTEE
UNITED STATES HOUSE OF REPRESENTATIVES

SUBJECT: Weather Satellite Systems and Weather Forecasting Capabilities

STATEMENT OF: Mr. Ralph O. Stoffler
Director of Weather

July 7, 2016

NOT FOR PUBLICATION UNTIL RELEASED BY THE
SUBCOMMITTEE ON THE ENVIRONMENT
SPACE, SCIENCE, AND TECHNOLOGY COMMITTEE
UNITED STATES HOUSE OF REPRESENTATIVES

Introduction

Chairman Bridenstine, Ranking Member Bonamici, and distinguished members of the Subcommittee, thank you for this opportunity to discuss Air Force's weather satellite systems and weather forecasting capabilities. Thank you for the opportunity to join Dr. Stephen Volz from the National Oceanic and Atmospheric Administration (NOAA). We, at the Air Force, welcome your interest and the opportunity to discuss these important topics.

The purpose of my testimony today will be to highlight the Air Force weather forecasting capability and operational use of weather satellite systems.

Weather Satellite Programs

The Air Force relies on an international family of systems of geostationary (GEO) and low-earth orbiting (LEO) satellites to provide global meteorological coverage. This family of systems impact operational missions such as remotely piloted aircraft (RPA), close air support, Special Forces, and airborne and space-based intelligence, surveillance and reconnaissance (ISR) assets.

In 1962, the Defense Meteorological Satellite Program (DMSP) was first flown to support National Reconnaissance Office (NRO) operations. Over the years, the program was transferred to the Air Force and has flown in both early and mid-morning LEO orbits. Today, DMSP is flown in the morning orbit per the National Space Policy (2010).

In accordance with a Deputy Secretary of Defense memo, the Air Force will not take actions regarding DMSP-20 that might preclude inclusion of the satellite in the set of alternative solutions under consideration for addressing satellite-based environmental monitoring (SBEM) requirements until after September 1, 2016. If the Department decides to launch DMSP-20 in order to meet SBEM requirements, it is recognized that we will need to work with Congress to request permission and obtain the necessary legislative authorizations and appropriations.

The Air Force remains focused on executing a two-phased acquisition approach for the Weather Satellite Follow-on (WSF) program to meet the remaining three Joint Requirements Oversight Council (JROC) validated materiel requirements for SBEM: Ocean Surface Vector Winds (Gap 3), Tropical Cyclone Intensity (Gap 8), and Energetic Charged Particle characterization (Gap 11). The Operationally Responsive Space (ORS) office will work with the Space and Missile Systems Center Remote Sensing Systems Directorate (SMC/RS) to develop and launch a technology demonstration (designated ORS-6) focused on the nearest term Gaps (3 and 8) in September 2017. For Phase 2, the current plan is to launch an operational WSF objective system to fully meet the three JROC-validated materiel requirements by 2022.

The DoD and Department of Commerce have enhanced their efforts to manage the family of systems risks by elevating the level of interaction to the Under Secretary of the Air Force, Space and the Office of the Secretary of Defense (Policy) (OSD(P)) at a senior executive level. The Air Force connects with NOAA on use of U.S. assets, and the OSD(P) office engages with them on international partnership advocacy. These interactions occur on a continuing basis to ensure pertinent weather information is available over the long-term.

Air Force's Weather Capabilities and Partnerships

The Air Force is one of the few organizations within the U.S. Government that has a global forecasting responsibility. Our meteorological production is more than just providing aviation weather services. We provide global weather and climate information to the Air Force, Army and Intelligence Community. Our Combatant Commanders demand timely, reliable, and actionable meteorological information, on both unclassified and classified networks, so they can understand the environmental impacts that affects all phases of military operations. Additionally, we are called to provide weather lead nation capabilities to our coalition and allied partners. We also take seriously our role of providing our model data and observations to our United States partners in order to improve the nation's weather forecasting capabilities.

We've seen demand for our products and services increase as decision makers look for tools and information to help them better understand risk and prepare for the future. This will require us to receive more observations to improve our numerical weather prediction models to meet increasing demands for more accurate and reliable forecasts and warnings.

While our computer predictions have improved, it is the dedication of our skilled Airman that make it all possible. Our Total Force Airmen are trained and educated on terrestrial and space weather impacts to the warfighting mission. We strive to minimize the impact of weather threats to friendly forces while simultaneously capitalizing on weather conditions that maximize the operational advantage over enemy forces. We must consider the full range of weather operations from climate to microscale weather events, prepared to support operations ranging from Humanitarian Assistance in partnership with departments outside the DoD, local field training events, to theater campaign plans, and major contingency operations exploiting our capability. Our Airmen use Air Force tactical sensors to develop an environmental picture of the battle space and minimize our data gaps. We deploy alongside and embed with Air Force fighter squadrons, Army battalions, and Special Forces Groups to ensure the warfighter completely understands the environmental impacts to their missions. We also produce data on classified models to ensure operational security and assessment on foreign capabilities. Air Force personnel uses military tactical decision aids to correlate platform or sensor degradation with weather impacts. Our data is also fed into DoD command and control systems to ensure planning and operational impacts are mitigated or minimized.

Today's world dynamics drive us to deliver more precise forecasts and assessments. Our ability to monitor environmental changes are based on timely access to data with necessary assurances that we can trust the data. These data are used by our global short-term terrestrial and space weather forecasting systems. The more data we receive, the better our predictions and impact assessments become.

We receive data from our coalition and North Atlantic Treaty Organization (NATO) partners through cooperative engagements. Additionally, we incorporate interagency and commercial data so we can focus our capabilities for the global mission. A global satellite and in situ system of systems are necessary to provide us insight into weather affecting military operations worldwide over the course of a few hours, days or weeks in advance.

We have partnerships with academia and private sector for research on specialized models such as clouds and aerosols for military unique requirements. Once we receive the information within our networks, we work to ensure we can maintain our capabilities during times of crises.

Today, the Air Force has several operational agreements with NOAA which covers our continental United States Doppler radar network, exchanges of data and meteorological satellite information, and National Weather Service's continuity of operations plans. We also participate on numerous committees and working groups throughout the federal enterprise. With any organization, we could always improve our communication within the enterprise.

Future Capabilities

We are building a unified framework, which is a scalable system, which allows us maximum flexibility to run higher resolution areas, short term forecasts, and longer term forecasts for mission planning. We recognize we need to continue to improve our capabilities for areas such as remote piloted aircraft, urban operations, space weather observations and warnings, trafficability of land forces, global water assessments, and land surface information. We must plan for changes in our future weather support for the next generation capabilities and needs, and the Air Force weather community needs to be quick, flexible and agile. We need the ability to assimilate our own unique military datasets from ground and aerial platforms, our organic environmental sensors, and sensors on soldiers.

In the future, we do foresee commercial providers potentially providing an essential element of data and information within our enterprise. Before we incorporate any data, organic, public or commercial, into our models and observational assessments, we must ensure that the data is accurate, reliable, and can be validated so that the accuracy of our operational forecasting models do not suffer. The Combatant Commander wants assurance from us that we are providing the best weather and climate information for the decision-making process. Our capabilities must precisely and predictively provide the right data and information, in the right amount, at the right time, especially since DoD will continue to face an increasingly complex global security environment.

CONCLUSION

The Air Force weather community is a vital component of the Department of Defense and the U.S. Government to ensure our military forces possess a meteorological asymmetric advantage over our adversaries, mitigate risks, and become more resilient from the effects of weather. We must prepare to continue to show initiative, be adaptable, and be innovative to allow weather operations to provide relevant knowledge, data, and information to the Joint Warfighter in this increasingly complex world.

The Air Force remains committed to ensuring our capability supports our global national security objectives. Our warfighters deserve our absolute best and we intend to provide it to them. I am proud of our in-garrison and deployed weather Airman who deliver critical products and services every day to help keep our military safe and mitigate the environmental impacts to our sensors and platforms.

Thank you again for the opportunity to testify before you today. I am happy to answer any questions you may have.

BIOGRAPHY

UNITED STATES AIR FORCE

RALPH O. STOFFLER

Ralph O. Stoffler, a member of the Senior Executive Service, is the Director of Weather, Deputy Chief of Staff for Operations, Headquarters, U.S. Air Force, Washington, D.C. In this capacity, he is responsible for the development of weather and space environmental doctrine, policies, plans, programs, and standards in support of Army and Air Force operations. He is further responsible for overseeing and advocating for Air Force weather resources and monitors the execution of the $320 million per year weather program. He is the functional manager for 4,300 total-force weather personnel and interfaces with Air Force major commands and the U.S. Army regarding full exploitation of Air Force weather resources and technology. He also represents the Air Force for interagency weather activities with the Department of Commerce, the National Aeronautics and Space Administration, and the Federal Aviation Administration. Mr. Stoffler advises the Secretary of the Air Force and Chief of Staff of the Air Force on atmospheric and space weather and climate matters and is the Department of Defense executive agent for modeling and simulation of the Air and Space Natural Environment.

Prior to his current position, Mr. Stoffler served as the Acting Director of Weather and Technical Director for the Directorate of Weather. As Technical Director, he was responsible for assessing innovative technologies for Space and Atmospheric Weather exploitation with applications to enhance Air Force capabilities, to include developing strategies to plan, modify, and integrate relevant weather capabilities to the Air Force.

Mr. Stoffler is a retired Air Force colonel with 30 years of service and experience in Army operations, pilot instruction, planning, programming, resources, budget, and requirements. He served as a squadron commander as well as weather division chief and major command functional in Europe. He retired in 2011 as the Deputy Director of Weather at Headquarters, U.S. Air Force, Washington, D.C.

Mr. Stoffler was born in Crailsheim, Germany and is a graduate of Nürnberg American High School in Germany. He holds a Bachelor of Science degree in Meteorology from the University of Oklahoma and a Master of Science degree in Systems Management from the University of Southern California.

EDUCATION

1980 Bachelor of Science, Meteorology, University of Oklahoma, Norman
1985 Squadron Officer School, Maxwell AFB, Ala.
1989 Master of Science, Systems Management, University of Southern California, Los Angeles
1995 Air Command and Staff College, Maxwell AFB, Ala.
1999 Air War College, Maxwell AFB, Ala.

CAREER CHRONOLOGY

1. February 1981 - February 1985, Assistant Staff Weather Officer to 2nd Armored Cavalry Regiment, 7th Weather Squadron, Feucht Army Airfield, Germany
2. March 1985 - October 1987, Chief of Scheduling, 14th Student Squadron, Columbus Air Force Base (AFB), Miss.
3. November 1987 - July 1989, Chief, 22nd Air Force Weather Support Unit, Travis AFB, Calif.
4. August 1989 - October 1991, Commander Detachment 2, 17th Weather Squadron, Travis AFB, Calif.
5. November 1991 - June 1992, Weather Flight Commander, 60th Operations Support Squadron, Travis AFB, Calif.
6. June 1992 - June 1994, Chief, Weather Plans, 7th Weather Squadron, supporting U.S. Army in Europe/4th Allied Tactical Air Force Central Army Group Weather Support, Heidelberg Army Installation, Germany
7. June 1994 - June 1996, Director of Operations, 617th Weather Squadron, Heidelberg Army Installation, Germany
8. July 1996 - June 1998 Chief, Requirements, Weather Division, Directorate of Operations, Headquarters U.S. Air Forces in Europe (USAFE), Ramstein Air Base, Germany
9. July 1998 - July 1999, Commander, USAFE Operational Weather Squadron, Sembach Air Base, Germany
10. August 1999 - June 2001, Chief of Reengineering, Directorate of Weather, Headquarters U.S. Air Force, the Pentagon, Washington, D.C.
11. July 2001 - November 2003, Chief Resources and Programs, Directorate of Weather, Headquarters U.S. Air Force, the Pentagon, Washington, D.C.
12. December 2003 - June 2007, Chief Weather Division, Air and Space Operations, Headquarters USAFE, Ramstein Air Base, Germany
13. June 2007 - March 2011, Deputy Director of Weather, Directorate of Operations and Training, Deputy Chief of Staff, Air and Space Operations, Plans and Requirements, Headquarters U.S. Air Force, Washington, D.C.
14. March 2011 - February 2014, Technical Director for Weather, Directorate of Operations and Training, Deputy Chief of Staff, Air and Space Operations, Plans and Requirements, Headquarters U.S. Air Force, Washington, D.C.
15. February 2014 - October 2015, Acting Director of Weather, Deputy Chief of Staff, Operations, Headquarters U.S. Air Force, Washington, D.C.
16. October 2015 – present, Director of Weather, Deputy Chief of Staff, Operations, Headquarters U.S. Air Force, Washington, D.C.

MAJOR AWARDS AND DECORATIONS

Legion of Merit
Meritorious Service Medal with seven oak leaf clusters
Joint Commendation Medal
Army Commendation Medal
Air Force Achievement Medal

(Current as of November 2015)

Chairman BRIDENSTINE. I'd like to thank the gentleman for his testimony.

Ms. Chaplain, you're recognized for five minutes.

TESTIMONY OF MS. CRISTINA CHAPLAIN, DIRECTOR, ACQUISITION AND SOURCING MANAGEMENT, GOVERNMENT ACCOUNTABILITY OFFICE

Ms. CHAPLAIN. Chairman Bridenstine, Chairman Smith, Ranking Member Johnson, Ranking Member Bonamici, and Members of the Subcommittee, thank you for inviting me to discuss GAO's recent work on defense weather satellites, DOD's polar-orbiting weather satellites, known as DMSP, currently cross the equator in the early and midmorning orbits while NOAA satellites cross the equator in the afternoon orbit. DOD will not continue replacing satellites in the midmorning orbit as it was decided in the aftermath of the NPOESS program that the United States would rely on the Europeans for this orbit.

In addition, last year, DOD was directed not to launch the last DMSP satellite planned for the early-morning orbit in light of Congressional concerns with lack of planning, coordination, and execution of activities to continue meeting DOD's weather requirements. But because the 19th DMSP satellite in the early-morning orbit recently failed prematurely, DOD has put dismantling of its last satellite on hold.

DOD undertook an analysis of alternatives for future weather satellites from 2012 to 2014. We were mandated by the Congress to review this study. Undertaking the analysis was a good step. In the past, we have found satellite programs did not perform a rigorous analysis or conducted one with a solution already in mind.

In addition, DOD is considering significant changes to its future space architectures to increase resiliency and is operating under a constrained budgetary environment, which ultimately means DOD needs to find ways to reduce the cost of acquisition either by paring back its requirements or doing business differently. A thorough analysis of alternatives can help DOD navigate all these challenges.

Ideally, DOD would have conducted this analysis in the aftermath of the cancelation of NPOESS in 2010. By the time it started its analysis in 2012, it was already facing a gap for measuring ocean winds and more gaps were looming. The lag in planning for a new satellite system is not unique to weather. The GAO has been concerned about similar lags from its warning satellites and protected communication satellites. The longer it takes to assess and decide on what path to take the more DOD is at risk of facing critical gaps or having to continue buying legacy satellites.

We found DOD made an effort to plan for future weather satellites with a more cost-effective approach in mind, including consideration of which capabilities DOD needed to provide and which could be provided by leveraging other sources of data. The effort to rationalize requirements is also a positive step. Too often, past programs sought to answer to many requirements, all with the most advanced technologies. The technology and design problems encountered by NPOESS were partly due to problems with reigning in requirements.

We also found the analysis was useful for informing plans for new satellites that can measure ocean winds and tropical cyclone intensity and for a new space weather sensor that could be integrated on other satellites. However, we found the analysis was less useful for informing plans for DOD's two highest priority capabilities, cloud characterization and theater weather imagery data, now facing near-term gaps over the Indian Ocean. While DOD consulted with a wide range of stakeholders in conducting the analysis, it did not effectively collaborate with NOAA, which represents DOD's interests to international partners.

Specifically, NOAA was not involved in the reviews or the analysis or regular discussions with the study leadership team, the discussions were had with the technical consultant to NOAA. The lack of formal collaboration and coordination with NOAA contributed to an incorrect assumption about the continued availability of critical weather data from European satellites. As a result, the analysis did not fully assess solutions for these high-priority capabilities.

Because DOD did not thoroughly evaluate its top-two weather priorities during the analysis, DOD is now assessing how to fill these gaps leading to additional lags and planning. The failure of DMSP satellite and the termination of DMSP–20 have heightened the need to do so. It should also be noted that ineffective coordination has been a recurring problem in space notably with the NPOESS program but with other space programs as well.

In closing, we recognize that this type of analysis is extremely challenging to conduct, more so given the rigor and scope DOD applied to it. But in light of the importance of cloud characterization and theater weather imagery data to DOD's mission, it was incumbent on the Air Force to work more effectively with NOAA. Since our report, they have taken actions, and I can talk about those during the hearing.

This concludes my statement, and I'm happy to answer any questions you have.

[The prepared statement of Ms. Chaplain follows:]

United States Government Accountability Office

GAO

Testimony
Before the Subcommittee on Environment, Committee on Science, Space, and Technology, House of Representatives

For Release on Delivery
Expected at 10 a.m. ET
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DEFENSE WEATHER SATELLITES

DOD Faces Acquisition Challenges for Addressing Capability Needs

Statement of Cristina T. Chaplain, Director, Acquisition and Sourcing Management

GAO-16-769T

GAO Highlights

Highlights of GAO-16-769T, a testimony before the Subcommittee on Environment, Committee on Science, Space, and Technology, House of Representatives

July 2016

DEFENSE WEATHER SATELLITES

DOD Faces Acquisition Challenges for Addressing Capability Needs

Why GAO Did This Study

Weather data are instrumental for planning, executing, and sustaining U.S. military operations and for meeting civilian needs, such as weather forecasting and climate research. As existing weather satellite systems age, DOD faces potential gaps in its space-based weather monitoring capabilities. As a result, DOD and other stakeholders, including the military services, the intelligence community, and U.S. civil agencies such as NOAA, are now in a precarious position to fill key capability gaps with immediate and near-term solutions. DOD conducted an AOA to identify and compare the operational effectiveness and life cycle costs of potential solutions.

This testimony is based on a report GAO issued in March 2016 on its assessment of DOD's AOA and focuses on the extent to which it informed DOD's plans for providing weather-related capabilities and addressed input from stakeholders.

GAO reviewed DOD's AOA documents and interviewed DOD officials, including stakeholders within the military services, and NOAA officials.

What GAO Recommends

In the March 2016 report, GAO recommended that DOD establish formal mechanisms for coordination with NOAA, among other things, and DOD concurred.

View GAO-16-769T. For more information, contact Cristina Chaplain at (202) 512-4841 or chaplainc@gao.gov.

What GAO Found

GAO found in March 2016 that the Department of Defense (DOD), in conducting a requirements review and Analysis of Alternatives (AOA) from 2012 to 2014, generally performed a thorough review for identifying capability gaps in meteorological and oceanographic data—also referred to as weather data—that needed to be met and determining the operational benefit of satisfying these gaps.

In doing so, the AOA determined that some capabilities with military utility could be covered by other assets or addressed with modeling development. The AOA also offered analysis that was useful for informing plans for a space-based solution for three capabilities facing near-term needs: ocean surface vector wind, tropical cyclone intensity, and energetic charged particles. GAO found that DOD was developing plans based on this analysis for a Weather System Follow-on program to address these areas.

The AOA was less useful for informing plans for two of the highest-priority capabilities—cloud characterization and theater weather imagery data—now facing near-term gaps over the Indian Ocean. While DOD consulted with a wide range of stakeholders in conducting the AOA, it did not effectively collaborate with the National Oceanic and Atmospheric Administration (NOAA), which, on a case-by-case basis represents DOD's interests with international partners. Specifically, NOAA was not involved in reviews of the AOA or regular discussions with AOA study leadership. The lack of formal coordination and collaboration with NOAA, such as employing a mechanism that identified roles and responsibilities for the two agencies during the AOA, contributed to an incorrect assumption about the continued availability of critical weather data from European satellites. As a result, the AOA did not fully assess solutions for these high priority capabilities.

GAO reported that DOD was exploring options outside of the AOA process for mitigating these pending capability gaps, including continued or increased reliance on data provided by international partners.

Chairman Bridenstine, Ranking Member Bonamici and Members of the Subcommittee:

I am pleased to be here today to discuss the Department of Defense's (DOD) efforts to sustain and improve its space-based weather monitoring capabilities. Meteorological and oceanographic data—also referred to as weather data—are key to providing information for the successful planning, execution, and sustainment of U.S. military operations and for civilian uses, such as weather forecasting and climate research. As DOD's primary existing weather satellite system—the Defense Meteorological Satellite Program (DMSP)—ages and other satellites near their estimated end of life, DOD faces potential gaps in its space-based weather monitoring capabilities which may affect stakeholders that use them, including the military services, the intelligence community, and U.S. civil agencies such as the National Oceanic and Atmospheric Administration (NOAA). Today, I will provide background on DOD efforts to replenish its weather satellites and a brief overview of our recent review of the analysis DOD conducted to assess options for future weather satellites.

DOD has been challenged to replenish its weather satellites. After two unsuccessful attempts to develop follow-on programs from 1997 through fiscal year 2012, DOD and other stakeholders who rely on weather monitoring data are now in a precarious position in which key capabilities require immediate and near-term solutions. From February 2012 through September 2014, DOD conducted a requirements review and its Space-Based Environmental Monitoring (SBEM) Analysis of Alternatives (AOA) to identify and compare the operational effectiveness and life cycle costs of potential solutions for providing SBEM capabilities. An AOA—a key analysis in DOD's acquisition process—is intended to inform a decision on the most cost effective solution for meeting validated capability requirements and identify a wide range of solutions with a reasonable likelihood of providing the needed capabilities.

My statement is based on a report we issued earlier in March 2016 on our assessment of DOD's SBEM AOA and focuses on the extent to which the SBEM AOA addressed input from stakeholders and informed DOD's plans for providing SBEM capabilities.[1] For that report, we reviewed relevant DOD and GAO documents to develop an understanding of the requirements and guidance for conducting an AOA and reviewed the AOA documents and interviewed DOD officials involved in conducting and reviewing the AOA to understand how it was developed. We also interviewed users and providers of DOD SBEM data (stakeholders), such as military service, intelligence community, and NOAA officials, to gain their perspectives on how stakeholder views were incorporated into the AOA. Additionally, we interviewed industry officials about ways to effectively assess options for providing SBEM capabilities, reviewed documents, and interviewed DOD officials about plans and decision making processes for providing future SBEM capabilities. We also interviewed NOAA officials about activities of the international SBEM community to understand potential effects on DOD's plans. Our work was performed in accordance with generally accepted government auditing standards.

Background

Since the 1960s, the United States has operated meteorological polar-orbiting satellite systems that provide global high-resolution observations—such as cloud cover, winds, precipitation, atmospheric temperature, and sea ice conditions—ideal for tactical weather support and long-range numerical weather prediction. DOD with its DMSP satellites, and NOAA with its Polar-orbiting Operational Environmental Satellite (POES) and Suomi National Polar-orbiting Partnership satellite (the first in the Joint Polar Satellite System), rely on each other's satellite systems to provide the data to meet their respective needs.[2] NOAA established the JPSS program in 2010 to replace aging polar satellites and provide critical environmental data used in forecasting the weather. NOAA, with assistance from the National Aeronautics and Space

[1]GAO, *Defense Weather Satellites: Analysis of Alternatives Is Useful for Certain Capabilities, but Ineffective Coordination Limited Assessment of Two Critical Capabilities*, GAO-16-252R (Washington, D.C.: March 10, 2016).

[2]Polar-orbiting satellites in low Earth orbit constantly circle the earth in an almost north-south orbit over the poles. Each successive orbital pass occurs at the same local time of day, such as early morning, mid-morning, and afternoon. DOD's DMSP satellites cross the equator in the early and mid-morning orbits and NOAA's satellites cross the equator in the afternoon orbit. The United States also relies on a European satellite, the Meteorological Operational satellite, currently crossing the equator in the mid-morning orbit.

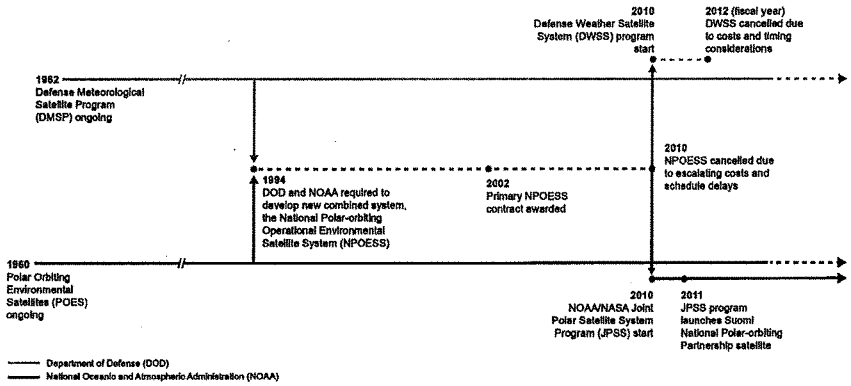
Administration (NASA), has developed the Joint Polar Satellite System to meet the responsibility for coverage in the afternoon orbit. DOD has been involved with two previous efforts to develop a replacement for DMSP, both of which were cancelled:

- National Polar-orbiting Operational Environmental Satellite System (NPOESS)—Tri-agency program between DOD, NOAA, and NASA to replace both DMSP and POES; started in 1997 and cancelled in 2010 due to escalating costs and schedule delays.
- Defense Weather Satellite System—DOD program intended to continue providing weather observations from the morning orbit following NPOESS cancellation; started in 2010 and cancelled in fiscal year 2012 because the program was considered early-to-need with unsustainable costs.[3]

Figure 1 below illustrates the timeline for the past DOD weather satellite acquisitions along with the timeline for NOAA's weather satellite development.

[3] In May 1994, a Presidential Decision Directive required DOD and the Department of Commerce through NOAA to converge their two separate weather satellite programs into a single program capable of satisfying both military and civilian requirements. Presidential Decision Directive NSTC-2, Convergence of U.S. Polar-Orbiting Operational Environmental Satellite Systems (May 5, 1994). DOD was responsible for the NPOESS acquisition, NOAA was responsible for overall program management and satellite operations, and NASA was responsible for facilitating the development and incorporation of new technologies. After NPOESS was cancelled in 2010, DOD was given responsibility for covering the early morning polar orbit and started a separate program, the Defense Weather Satellite System.

Figure 1: Time Line of Efforts to Replace DMSP



Source: GAO analysis of DOD and NOAA information. | GAO-16-769T

The challenges DOD has faced with replenishing its current weather satellite system, especially considering those encountered under the NPOESS program, are not surprising. Our prior work has found that DOD and civil government space programs have long been characterized by large cost overruns and schedule delays.[4] The types of management and oversight problems we commonly found include: optimistic cost estimating, funding gaps, lax oversight, poor contractor performance, parts quality problems, and frequent program manager turnover. Our reviews in recent years have made a number of recommendations aimed at putting DOD on a better footing as it considers and implements

[4]GAO, *Space Acquisitions: Challenges Facing DOD as it Changes Approaches to Space Acquisitions*, GAO-16-471T (Washington, D.C.: Mar. 9, 2016); GAO, *Space Acquisitions: Some Programs Have Overcome Past Problems, but Challenges and Uncertainty Remain for the Future*, GAO-15-492T (Washington, D.C.: Apr. 29, 2015); GAO, *Polar-Orbiting Satellites: With Costs Increasing and Data Continuity at Risk, Improvements Needed in Tri-agency Decision Making*, GAO-09-772T (Washington, D.C.: June 17, 2009).

significant changes for space programs. For example, we recommended that when planning for the next phase of competition for launches, the Air Force use an incremental approach to the next acquisition strategy to ensure that it does not commit itself to a strategy until data is available to make an informed decision, and DOD concurred.[5]

Our prior work has shown that DOD satellites have also tended to be monolithic—attempting to satisfy the needs of many and to get the most capability out of a satellite as possible in light of the high cost of launching them. While this approach met the needs of multiple missions, it further complicated satellite design. Our work on the NPOESS program has shown that without clear lines of authority, conflicts between satellite users hampered decisions, such as for requirements. Cost and schedule growth in DOD's space programs was sometimes driven by inherent technical, design, and engineering risks, but more often than not, our reports found that management and oversight problems were behind cost and schedule growth. Consequently, as DOD moves forward with its efforts to replenish its weather satellites, careful consideration of ways to address or avoid these longstanding challenges may help to deliver needed capabilities within cost and schedule goals.

DOD's SBEM Analysis of Alternatives Is Useful for Certain Capabilities, but Ineffective Coordination Limited Assessment of Two Critical Capabilities

Our March 2016 report found that DOD made an effort to plan for future capabilities with a more cost-effective approach in mind, including consideration of which capabilities DOD needed to provide and which could be provided by leveraging other sources of data. Specifically, we found that DOD generally conducted a thorough review for identifying capability gaps that needed to be met and determining the operational benefit of satisfying these gaps. In doing so, the study determined that some gaps could be better addressed by non-space-based solutions or improvements to modeling. We also found that the AOA offered analysis that was useful for informing plans for a space-based solution for three capabilities with near-term needs—ocean surface vector wind, tropical cyclone intensity, and energetic charged particles—and that other capabilities with military utility could be covered by other assets or addressed with modeling development. In March 2016 we reported that DOD is developing plans based on this analysis for a Weather System

[5]GAO-16-471T.

Follow-on program to provide ocean surface vector wind and tropical cyclone intensity capabilities, though it may not be available in time to avoid short term gaps. For the third capability, energetic charged particles, the Air Force has developed a plan to collect data by hosting sensors on all of its satellites.

However, we found that the AOA was less useful for informing plans for the two highest-priority capabilities—cloud characterization and theater weather imagery data—now facing near-term gaps over the Indian Ocean, because it did not fully assess solutions to provide these capabilities. While DOD consulted with a wide range of DOD stakeholders in conducting the AOA, it did not effectively collaborate with NOAA (on a case-by-case basis, NOAA represents DOD's interests with international partners regarding SBEM data). Specifically, NOAA was not involved in reviews of the AOA or regular discussions with AOA study leadership.[6] The lack of formal coordination and collaboration with NOAA, such as employing a mechanism that identified roles and responsibilities for the two agencies during the AOA, contributed to an incorrect assumption about the continued availability of critical data from European satellites. Specifically, the AOA study determined that the likelihood the gap would not be filled was low, based on historical trends, and as a result DOD did not fully assess solutions for cloud characterization and theater weather imagery data. However, NOAA officials who work closely with international partners had an understanding of the plans for European satellites at the time, and during the AOA study period, publicly available reports from an international coordination group indicated uncertainty about extended European coverage over the Indian Ocean.[7] We found in March 2016 that because of a potential near-term gap for these capabilities, DOD is exploring options outside of the AOA process for

[6]While several NOAA officials were assigned to one of the AOA working groups, according to one NOAA participant, the interaction entailed receiving emails rather than participating in meetings or regular dialogue throughout the AOA.

[7]These reports were published by the Coordination Group for Meteorological Satellites, which has a range of international member organizations, including NOAA and the European agency responsible for the Meteosat system, EUMETSAT. Coordination Group for Meteorological Satellites, *Report of the 41st Meeting of the Coordination Group for Meteorological Satellites*; (Tsukuba, Japan: July 8-12, 2013); *EUMETSAT's Plans for Indian Ocean Coverage Beyond 2013* CGMS-41 EUM-WP-15 v1a (July 2, 2013) ; and *Report of the 40th Meeting of the Coordination Group for Meteorological Satellites* (Lugano, Switzerland: Nov. 5-8, 2012).

mitigating these gaps, including continued or increased reliance on data provided by international partners.

Ideally, DOD could have conducted an SBEM AOA when pursuing new acquisitions in the aftermath of the NPOESS cancellation. But because the analysis was conducted 2 years later, the AOA team faced pressures to complete the study in time to inform decision making for near term needs. However, DOD's effort to analyze options in the SBEM AOA, including consideration of ways to leverage other sources of data, was a positive step toward a more cost-effective approach to providing SBEM capabilities. As a result of the AOA's limitations, though, as well as cancellations of prior efforts to develop a follow-on system to DMSP, DOD is faced with having to quickly initiate efforts to assess potential solutions for near-term capability gaps that were not fully assessed in the AOA.

Because decisions about whether to provide DOD solutions for SBEM capabilities are dependent on the availability of data from U.S. civil government and international partner satellites, sufficient and reliable information to determine the level of risk DOD is willing to take is crucial. Formalizing coordination and collaboration to identify roles and responsibilities in planning for SBEM capabilities could offer DOD and NOAA the opportunity to help ensure effective communication about the availability and reliability of data from U.S. civil government and international partner satellites and better inform decision making in the future. Consequently, to help ensure DOD is sufficiently informed about the availability and reliability of data from U.S. civil government and international partner satellites as it plans for future SBEM capabilities that rely on such satellites, in our 2016 report we recommended that the Secretary of Defense ensure the leads of future SBEM planning efforts establish formal mechanisms for coordination and collaboration with NOAA that specify roles and responsibilities and ensure accountability for both agencies. DOD concurred with our recommendation. In March 2016, we reported that DOD and NOAA officials stated that since the conclusion of the AOA study period, DOD and NOAA have increased their communication by discussing ways to leverage international partner satellite data and the possibility of establishing and employing formal coordination and collaboration arrangements.

These are encouraging actions, but it is too early to tell whether they will be effective or sustainable. We reported in 2012 that past studies and reviews examining the leadership, organization, and management of national security space have found that there is no single authority responsible below the President for integrating space programs, and responsibilities for acquiring space systems are diffused across various DOD organizations as well as the intelligence community and civil agencies such as NASA and NOAA, who rely on these systems.[8] This fragmentation is problematic not only because of a lack of coordination that has led to delays in fielding systems, but also because no one person or organization is held accountable for balancing government-wide needs against wants, resolving conflicts and ensuring coordination among the many organizations involved with space acquisitions, and ensuring that resources are directed where they are most needed.

Recent events have further heightened DOD's challenge in addressing gaps in weather monitoring data. Because of a lack of funding, in December 2015, the Air Force moved to terminate activities to integrate and launch the last DMSP satellite.[9] Additionally, in February of this year, the latest DMSP satellite to be placed in orbit unexpectedly failed. These events have increased the risk of some capability gaps occurring even sooner. With potential gaps starting as early as this year, it is important for DOD to make decisions in a timely manner, but based on informed analysis that considers stakeholder input.

Chairman Bridenstine, Ranking Member Bonamici and Members of the Subcommittee, this concludes my statement. I would be pleased to respond to any questions you or other Members of the Subcommittee may have.

GAO Contact and Staff Acknowledgments

For further information on this testimony, please contact Cristina Chaplain at (202) 512-4841 or chaplainc@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this statement. Individuals making key contributions to this testimony include Emily Bond, Erin Cohen, Brenna Derritt, Juli Digate,

[8]GAO, *2012 Annual Report: Opportunities to Reduce Duplication, Overlap and Fragmentation, Achieve Savings, and Enhance Revenue,* GAO-12-342SP (Washington, D.C.: February 28, 2012).

[9]DMSP-20 is in "safe keeping" at Lockheed Martin's satellite facility in Sunnyvale, California, where it receives minimal pre-launch preparation and requires less testing than traditional mission-ready storage. The Pentagon has pushed back a deadline to begin dismantling Defense Meteorological Satellite Program Flight 20 until Sept. 1, 2016.

Marie Ahearn, Michael Kaeser, Jay Tallon, Oziel Trevino, and Rich Horiuchi (Assistant Director).

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Ms. Chaplain currently serves as a Director, Acquisition and Sourcing Management, at the U.S. Government Accountability Office. She has responsibility for GAO assessments of military space acquisitions, NASA, and the Missile Defense Agency. She has recently led reviews on Defense weather satellites, the Global Positioning System, communications satellites, future space architectures, the Evolved Expendable Launch Vehicle, satellite user terminals, NASA's major space programs, and the James Webb telescope. She has also led a variety of other contracting-related and best practice evaluations for the GAO. Before her current position, Ms. Chaplain worked with GAO's financial management and information technology teams. Ms. Chaplain has been with the GAO for 25 years. She received a bachelor's degree, magna cum laude, in International Relations from Boston University and a Masters Degree in Journalism from Columbia University.

Chairman BRIDENSTINE. Thank you for your testimony, Ms. Chaplain.

We have with us—now, we're going to go a little bit out of order—but the chairman of the full committee, a good friend of mine from Texas, Mr. Smith, you are recognized for five minutes for an opening statement.

Mr. SMITH. Thank you, Mr. Chairman. I appreciate the opportunity to be able to go out of turn for an opening statement. And I want to thank our witnesses for being here today.

The Science Committee has held many hearings on NOAA's troubled weather satellite programs over the years. These problems largely stem from the federal government's ill-fated consolidation of civilian and military weather and climate systems, which created slow, costly, and inefficient interagency programs to handle our weather prediction.

In 2010, when it became apparent that the National Polar-orbiting Environmental Satellite System was a failure, the Administration canceled it and left the agencies, namely NOAA and DOD, to create their own individual polar programs. In NOAA's case, they initiated the JPSS satellite, which unfortunately has continually encountered delays, cost overruns and mismanagement.

Over the last several years, NOAA's spending for satellite operations has ballooned to account for roughly 40 percent of its total budget, over $2 billion. This prevents NOAA from adequately pursuing other important areas of science, service, and stewardship.

NOAA now proposes to move forward with the next series of weather satellites using the same technology, the Polar Follow-On. So I am concerned that the same problems that have occurred over the last ten years will continue. This Committee needs assurance that NOAA will get its government satellite spending under control and be able to meet future forecasting needs. Congress should not continue to fund an over-budget program that has not performed up to its standards.

So what is NOAA doing differently with its next series of satellites that justifies such high continued funding? I fear the answer is nothing. I am also not convinced that NOAA is adequately mitigating the very real possibility of a gap in our weather data. In the face of real threats, NOAA should be doing all it can to prevent data gaps, yet they continue to drag their feet and not consider all options. The growing private sector weather enterprise could mitigate NOAA's shortcomings through new technologies and sources of data, but NOAA shows that it will only take action if forced to do so.

If NOAA is afraid of innovation, maybe they shouldn't be in the business of deciding what technologies are needed for improved forecasting. For instance, commercial satellites equipped with the latest technology could help prevent data gaps, provide new kinds of advanced data, improve current and future model forecasts, and do so on a much faster timeline at lower cost than large and slow government systems. So why isn't NOAA considering these?

NOAA should absolutely consider the help that the private sector can provide. In this case, commercial innovation beats the status quo of slow, costly government systems. Faster, better, and cheaper solutions take vision, competence, and courage. NOAA needs more of these qualities.

Mr. Chairman, I look forward to hearing from our witnesses today about how we can get our nation's future weather data back on track and on time to provide our citizens with the critical weather forecasts they need and deserve.

Let me also say, regrettably, I have another committee markup going on at the same time, so I'm going to be shuttling back and forth between the committees.

Thank you, Mr. Chairman. I yield back.

[The prepared statement of Chairman Smith follows:]

COMMITTEE ON
SCIENCE, SPACE, & TECHNOLOGY
Lamar Smith, Chairman

For Immediate Release
July 7, 2016

Media Contacts: Kristina Baum
(202) 225-6371

Statement of Chairman Lamar Smith (R-Texas)
Examining the Nation's Current and Next Generation Weather Satellite Programs

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Chairman BRIDENSTINE. Thank you, Chairman, for your opening statement. Thank you to all of our witnesses for their testimonies.

Members are reminded that Committee rules limit questioning to five minutes. The Chair now recognizes himself for five minutes.

I wanted to start by addressing the issue that we recently had on another committee I serve on, the Armed Services Committee, with Meteosat-7, which was going to do cloud characterization and theater weather imagery over the Indian Ocean, which is critically important for our war fighters serving in that part of the world. We had hearings on our committee when we learned that Meteosat-7 was not going to be able to continue doing those functions and that the Europeans were not planning to replace it with what we thought they were going to plan to replace it with, so we started having hearings and trying to figure out what are we going to mitigate this gap with.

And then, ultimately, we just learned last week that the Europeans are indeed going to launch a new satellite and move Meteosat-8 over to a region that is close to where Meteosat-7 was so we can get some of the same capabilities back.

I wanted to ask Mr. Stoffler if you would comment on the process that we went through from believing we were secure in a solution to not having a solution and then going and finally looking like we've got a good solution. If you could share with us what the solution is and the process that we went through to get there.

Mr. STOFFLER. Chairman, I appreciate that question. And certainly you're very correct. We were planning all along that the Europeans would provide us the capabilities over the Indian Ocean. They, like us, have their own priorities and they had to make a change to their plans. When we were first informed of that possibility, we looked at all alternative options that were out there.

Certainly, there are other geostationary capabilities over the Indian Ocean and particularly provided both by Russia and China. Our systems are capable of receiving Chinese data, and we did an evaluation of that. When we determined the potential of hackings that took place at NOAA, we locked our systems down. We had the CIO of the Air Force evaluate the situation, and we were told unless this data was really highly operationally needed, we should not use it.

We then went to the Director of Operations to determine if we should use it, and the answer was clearly no. Once we were told that Chinese data is off the table, we had to find another alternative.

At that point in time, we began several actions. One was to go back to the Joint Staff and advise them of this change. We provided briefings, and we also began an outreach on the military side to work with our allies to see what they could do to convince our European allies to move over, and of course we outreached to our NOAA partners to see what they could do to help us in that regard.

I think we've been very successful, and the end result is we now have what I would call a multi-pronged attack to resolve that problem. First, as you've already said yourself, Europe has been most cooperative. Meteosat-8 is being moved over. It's going to cover the critical components of our operations in Syria and Iraq. We will experience a short gap over eastern Afghanistan, and our plan there is to work cooperatively with India to use Indian data to close that gap.

Chairman BRIDENSTINE. Now, would that happen immediately or is that—you said we're going to have a gap. How long is that gap going to be?

Mr. STOFFLER. We don't think that we're really going to have a gap. Right now, India—the Indian satellite is already operational. It's already there. The data is already available here in the United States at a variety of universities. It's a matter of getting here quicker and more efficiently so we can use it operationally.

Chairman BRIDENSTINE. Okay.

Mr. STOFFLER. And we're working in conjunction with our NOAA partners to make that happen for us, so we feel very positive that we're going to be able to do that.

Chairman BRIDENSTINE. At what point did you guys reach out to NOAA to seek assistance? Or did you?

Mr. STOFFLER. I think certainly at my level we had a lot of informal talks and what the best way forward was, but we didn't really reach out to NOAA formally until after we had made the decision that the Chinese data set would not be able to be used. At that point in time the Air Force A3 wrote a letter to NOAA, NESDIS in particular, asking to see if NOAA could help us possibly moving a spare NOAA satellite over the Indian Ocean.

Chairman BRIDENSTINE. I want to bring up something that I've heard as an idea. I'm not saying it's a good idea; I'm saying it's an idea, and I want to get your input on it. During the George W. Bush Administration, they established the National Executive Committee on Positioning, Navigation, and Timing to coordinate and provide high-level guidance for GPS. It was co-chaired by the Deputy Defense Secretary, the Deputy Transportation Secretary.

The executive committee only meets about twice a year, which seems doable even for people who are extremely busy, as I know you are. The National Executive Committee has a permanent staff, working groups, and includes every agency with GPS equities. Is it worth considering a national executive committee approach for weather to get attention, coordination, and guidance at the highest levels when we face these kind of gaps?

Mr. STOFFLER. Certainly from my perspective, Mr. Chairman, is that there are a significant number of coordination activities that take place already. We've got the Joint Center for Data Assimilation. We also work with the Development Testbed Center, so certainly at my level and below there's lots of coordination that takes place. I find that very effective.

During the NPOESS era, we actually had a meeting similar to that, a senior users' group meeting where NOAA, NASA, and the DOD got together pretty routinely to discuss things in a very high-level. As you have already attested yourself, the result of that wasn't necessarily positive so I'm not convinced that adding another level of high-level bureaucracy is going to improve the process.

Chairman BRIDENSTINE. Dr. Volz, what are your thoughts on that?

Dr. VOLZ. Thank you. I think that the points you make is the need for greater coordination at the senior executive level. And as

Mr. Stoffler mentioned, when the Air Force reached out to us after their Chinese assessment and asked for assistance, we were able to communicate to them our status on GOES but also that we have been working for some time with our European partners through an international Coordination Group on Meteorological Satellites for covering this particular observing system requirement over the Indian Ocean. So that had been in work for some time.

I bring that up because we have global coordination activities already in place for meteorological activities for—across all the major met agencies in the world. And this is one example where the need for observations over the Indian Ocean was well understood, and there had been a history and we knew it was going to be going away and there was a path for an interim solution to solve it.

So I think addressing the collaborative needs wouldn't necessarily require an executive committee but greater coordination between the DOD and NOAA as we serve in that role as the international agent for weather for the United States around the world and we have done for many, many years effectively.

Chairman BRIDENSTINE. All right. My time is expired. I'd like to recognize the acting Ranking Member, Mr. Grayson from Florida.

Mr. GRAYSON. Thank you. Mr. Stoffler, I want to congratulate you on your origins. As I frequently tell the Chair, not everybody can be so fortunate as to be from Oklahoma.

Mr. STOFFLER. That's correct.

Mr. GRAYSON. Tell me, what kind of data do DOD satellites collect other than weather data?

Mr. STOFFLER. If you're making reference to the defense meteorological satellite program, we have seven different sensors on there, and they collect weather information as well as space weather information.

Mr. GRAYSON. What are the sensors?

Mr. STOFFLER. Specifically, we have a sounder, we have——

Mr. GRAYSON. What's that?

Mr. STOFFLER. The sounder is something where we collect information regarding remote sensing of the atmosphere. This is data that you would incorporate into the models. The key essential that we have on DMSP is the EO/IR capability where we actually take pictures of the atmosphere to see the clouds, specifically visible imagery and infrared imagery.

Mr. GRAYSON. What other sensors?

Mr. STOFFLER. I'd have to give you a precise breakdown at another time, sir.

Mr. GRAYSON. All right. Well, give me an idea of what they're actually used for. What kind of data do they collect?

Mr. STOFFLER. Well, I mean, the primary mission is we take the actual pictures, the IR and the vis, and we incorporate it into a cloud depiction forecasting system. That is the primary purpose of the DMSP. We use the sounding data and we incorporate it into our models from a data simulation perspective, and we use the space weather centers in—to support of our ionospheric modeling system. So those three are the primary areas.

Mr. GRAYSON. I got the impression from your testimony that the information is used to provide—how shall I put this—weather reports to troops in the field. Is that correct?

Mr. STOFFLER. From the satellite perspective, we use the data in two aspects. One, clouds are very, very important to the war fighter, so if I'm sitting in the AOR and I'm planning a mission or strike and the air operations center wants to know five or six hours from now where are the clouds going to be, where's the cloud-free line of sight, where am I going to hit the target, DMSP provides this data were we can forecast and where those cloud-free areas are going to be. So from an RPA perspective, from a strike perspective, from a bombing perspective, that's where that helps.

The sounding data we use for the long-range forecasts out to 10 days to actually create numerical weather prediction on the bigger range weather features.

The other thing which the DMSP is very critical for is in the execution phase. If you want to know where a haboob is going to be or where you're going to have severe thunderstorm activity, again from an execution point of view, that's what we use that data for. And we make the data available via the DCGS backbone so they can actually see it downrange.

Mr. GRAYSON. Is that information used now or is it just something that's been used in the past? Let me be more specific. Has it been used in the past 30 days?

Mr. STOFFLER. Yes.

Mr. GRAYSON. Where?

Mr. STOFFLER. We use that information each and every day.

Mr. GRAYSON. Where do you use that?

Mr. STOFFLER. We use it in, we use it in, we use it in CENTCOM, we use it in PACOM, we use it in SOUTHCOM.

Mr. GRAYSON. Could you be more specific?

Mr. STOFFLER. Okay. I would say that at Kabul, for example, we would use that. At Bagram Air Force Base we would use that. We would use it over Syria. We would use it over our operations in Iraq. We would use it over places in Russia. We also use it in South America. We use it in Korea, and it's used in northern Europe. So basically any place where there's a DOD operation going on, we would use that data.

Mr. GRAYSON. I'm surprised to hear you mention South America. What's that all about?

Mr. STOFFLER. We have some counter-drug operations in South America, and we actually have a few weather teams deployed down there.

Mr. GRAYSON. All right. It sounds like the division of labor between you all and NOAA is somewhat ad hoc. Is that a fair statement?

Mr. STOFFLER. I would not say that it's ad hoc. Our mission is very focused OCONUS on military operations.

Mr. GRAYSON. But in terms of who covers what, that seems to be done almost on a case-by-case basis rather than according to some kind of master plan. Is that fair to say?

Mr. STOFFLER. I think you need to look at what I would call the international plan. From an international point of view, from a data-providing point of view, NOAA certainly provides from our perspective the two geostationary satellites, GOES East, GOES West. We use the two European satellites, and we use a Japanese satellite. We also use a European one. So I think there is an international plan of distribution of responsibilities regarding data collections.

Mr. GRAYSON. Dr. Volz, from your perspective, is the division of labor between NOAA and DOD ad hoc or is it according to some master plan?

Dr. VOLZ. I think the missions of the two agencies are very different, and the products and services the two agencies provide are different as well. NOAA has a very focused weather forecast alerts-and-warnings responsibility for the United States, and as part of our global observation generate the numerical weather predictions requires global observations. We also have oceans and coastal observation requirements, and products and services we provide.

When you think about speaking—it's not my field exactly—but what the DOD is providing is a very service-oriented delivery to their own resources or their own applications. We provide a general observation requirement in weather forecasting for all users, and it's up to our other users to come up with more specific, detailed recommendations in forecasts and products for their particular service application.

So I don't think it's overlap in terms of the mission requirements. Ours are broader and more general to the general populace, and DOD has a completely different mission from ours.

Mr. GRAYSON. My time is up. Thank you all.

Chairman BRIDENSTINE. Great questions. As somebody who serves in the United States military, maybe I can help. When it comes to mesoscale forecasting in Afghanistan, which is a smaller level, in Afghanistan that's not where NOAA is going to be serving the war fighter. NOAA is focused on the United States of America. The DMSP programs and all the weather satellite programs operated by the Department of Defense feed models that will ultimately enable me to determine whether or not I can use a laser-guided weapon or a GPS-guided weapon for a specific target in Afghanistan or some other part of the world. Of course, I did counter-drug operations in Central and South America as a Navy pilot, and I was very grateful that we had excellent weather data down south. It could have been better, but my goodness, weather in Central and South America changes so rapidly. You literally see the thunderstorms growing.

I'd like to now recognize Mr. Moolenaar from Michigan.

Mr. MOOLENAAR. Thank you, Mr. Chairman. And I want to thank our witnesses today.

I want to begin with Mr. Stoffler. If you—just on—after canceling the Defense Weather Satellite System, the Department of Defense initiated an analysis of alternatives for space-based environmental monitoring, and it's my understanding that the conclusions of this analysis prioritized a number of mission-critical issues for Department of Defense to pursue, and I just wanted to get your perspective. Is Department of Defense pursuing all the mission areas as prioritized in this analysis of alternatives?

Mr. STOFFLER. Thank you for that question, sir, and yes, we are. We are pursuing all of them. When we did the analysis, we reviewed the initial requirements of the NPOESS program. We revalidated 11 of the 12 original requirements as having clear military utility, and then we determined that a significant number of the needs that we had could be met by existing national and international assets, so we're focused on—only on buying material capabilities for gaps 3, 8, and 11, i.e., tropical cyclone monitoring, ocean vector winds, and the space-based energetic charged particle sensors.

Mr. MOOLENAAR. So you feel that this plan is helping to mitigate these gaps?

Mr. STOFFLER. No question, yes, it is.

Mr. MOOLENAAR. Okay. Ms. Chaplain, would you—any comments on that assessment at all?

Ms. CHAPLAIN. A couple things. I would add that the first two capabilities, cloud characterization, theater weather imagery, there are still questions about how to meet those capabilities, and DOD is still studying that after the AOA. During the AOA, they consulted some with NOAA on the possibility of using European satellites to fill some of those gaps, but because they didn't consult with them enough, they didn't get information that helped them form good assumptions for that study. So that's a still the question up in the air, those two capabilities.

Mr. MOOLENAAR. Okay. Thank you for that feedback.

Mr. Powner, I wondered, I understand that NOAA needs to launch the first polar satellite JPSS–1, as well as the follow-up JPSS–2 to have a more robust system, and after that, when does NOAA need to launch the remaining two satellites?

Mr. POWNER. Well, I think that's still in question. When you look at—our main concern is the potential gap right here and now between NPP and J–1. I think when you look at the plan for J–2 and you look at the follow-on programs, J–3 and 4, those gaps go away. They really go—the near-term issue is with ATMS on NPP and will it last long enough until we get J–1 up there and transition over to the ATMS on J–1. That's, I think, the key question in the near term.

When you look at the out year, there is a robust constellation being planned. In fact, they're even planning to store satellites 3 and 4, the follow-on programs, for relatively 2 to three years and then 5 to six years. That's the current plan. So after we get past this first hurdle, I think the robustness begins.

Mr. MOOLENAAR. Okay. And are we saving money by building satellites now? Is that your understanding?

Mr. POWNER. Well, that's the key question. When you look at the out-years satellites, there's economies of scale to go ahead and build these things quicker, especially if we're replicating what we're doing on J–2. And we get that. And we ought to take advantage of that. And we also ought to take advantage of some firm fixed prices because we've done these things. There's opportunities to save money.

But there's also a challenge with building them quickly and storing them. There's a cost with that. And you've also got to balance that with the annual appropriation process. How do you balance all those things? And I just think NOAA needs to be real clear in their plans forward that we're justifying the best decisions to ensure robustness but still do it where we're fiscally responsible.

Mr. MOOLENAAR. And then are you concerned at all about there may be emerging technologies that if we build things now that we wouldn't be able to take advantage of those new technologies?

Mr. POWNER. Absolutely. I mean, there's always, you know, leaps with some of these technologies that help with the forecasting with our observational sensors and the whole bit. So again, you know, we don't want to—there's some sweet spot in there, and what—finding that sweet spot where we store not excessively ensuring that we can actually enhance some of the sensors going forward, and I think finding that sweet spot, it's still kind of a TBD in our mind.

Mr. MOOLENAAR. Okay. Well, thank you very much.

And, Mr. Chairman, I yield back.

Chairman BRIDENSTINE. The gentleman yields back.

I now recognize the gentleman from Texas, Dr. Babin, for five minutes.

Mr. BABIN. Thank you, Mr. Chairman. And thank you, witnesses, for being here today.

Dr. Volz, it's my understanding that NOAA relies on data from the three distinct polar orbits, early morning, midmorning, and early afternoon, which are all being filled by different partners, NOAA, DOD, and the European satellite program, EUMETSAT. How important is each orbit?

Dr. VOLZ. In order to generate accurate forecasts and for our numerical weather modeling, we need distributed data and observations from around the globe as frequently as possible. The models we use right now are—rely on all three orbits for provision of data. So the timing, those 6:30 a.m., the 9:30 a.m., and the 1:30 p.m. timing are equally important to the generation of our data models in our forecasts.

Mr. BABIN. Okay. So the data from each orbit is weighed equally when integrated into numerical weather models? Is that the way that works?

Dr. VOLZ. I say the distribution of the timing of the data are equally important. You need that snapshot from different times of the day. We have different sensors in the different orbits, so some are more powerful than others, so the impact of individual measurements from an afternoon orbit may be more than the early-morning orbit because of the quality of the instrument—

Mr. BABIN. I see.

Dr. VOLZ. —but you need at least the weather and temperature soundings at those three orbits to support the overall numerical weather modeling.

Mr. BABIN. Okay. What would be the degradation of our weather forecasts if there was a gap or if a partner decided not to fill a certain orbit?

Dr. VOLZ. We've looked at over the years answering that question as we went through the generation of the JPSS program in a few years ago looking at what we called data denial studies or analyses of the impact of the loss of a particular orbit. And it does show up as a reduction in the accuracy of the forecasts in the three- to five- or seven-day forecast period when you remove one leg of that three-legged stool. And I can give you the specific numbers. I can't quote them off the top of my head, but there is a marked change in the accuracy of the forecast in the short-term forecasts with the loss of any one of those three.

Mr. BABIN. Well, if you can't provide exact figures, can you commit to this committee to do the appropriate research and studies to determine the exact benefit, importance of each separate orbit?

Dr. VOLZ. Yes, sir, we can take that

Mr. BABIN. Okay.

Dr. VOLZ. —and respond.

Mr. BABIN. Okay. Thank you.

Mr. BABIN. And then I'd like to ask several of you, as with most other government satellite acquisitions, weather satellite acquisition efforts consistently have experienced significant cost increases and schedule delays. Why is this so, and what can be done to your knowledge? Has anyone met cost schedule and performance goals with their weather satellite acquisition efforts? And I would say, Mr. Powner, if you would go first.

Mr. POWNER. Well, clearly, I think there's a lot of lessons learned looking at what happened with NPOESS and why we had such huge cost overruns in launches and delays in planned launches. One of the big things you can start with is the level of complexity that was associated with NPOESS. At one time there was an excessive amount of sensors. We got down to five. I think decreasing the complexity is the first start in ensuring that our requirements are real solid. Many times we ask for so many things in our requirements have a lot of nice-to-haves, but what do we essentially need. So that's been a real lesson learned looking back over the—both the GOES and the JPSS programs.

Mr. BABIN. Okay. And how about Colonel Stoffler if you don't mind?

Mr. STOFFLER. Well, I can certainly echo, sir, what was already mentioned, having been part of the NPOESS program. We tend to want to really build capabilities, which advances of the future. So if you make requirements that take you far in advance, there's increased risk. And if you look at DMSP, when you go from a capability that has two channels and you try to go to 24 channels, that really causes a lot of risk. So certainly from the DOD perspective, if you state requirements which are reasonable and allow you to do what you need to do, that's a key way of controlling cost.

Mr. BABIN. Okay. And then we probably have enough time for one more answer between Ms. Chaplain or Dr. Volz, whichever one.

Ms. CHAPLAIN. I like to add to that just because our work consistently looks at this question. I would add in addition to the issues which are very legitimate, oftentimes satellite programs attempt to invent technology during the acquisition phase, so if they run across natural discovery problems during that phase, it has a lot of repercussions that drive up costs and schedule.

In the case of NPOESS, oversight was a very big problem, as well as coordination among the three agencies. And I think weather satellites tend to be a little harder to do because of that. They span so many communities. You have to bring a lot of stakeholders together and work effectively to manage the program right. So I think going forward both agencies need to look at that issue.

Mr. BABIN. Okay. That's great. Did you have something you wanted to say, Dr. Volz?

Dr. VOLZ. Yes, please. I'd like to respond to that. I agree with both the points of our GAO representation—representatives have made. It's consistency and clarity, consistency of the requirements and clarity of the mission I think which are key. And the NPOESS example was a forced marriage between different organizations with different service provisions that we talked about earlier.

And I think the lesson was learned, and it has been applied on our JPSS program. In fact, since the 2011 initiation, we have held the Q–2 fiscal year 2017 launch date for the JPSS mission for the last five years plus. So we've been able—with changes and challenges that we have in development, we've managed to keep that launch schedule on track. And we've addressed the changes in requirements by holding to a firm baseline of requirements, and that's the provision of the follow-ons is that we do not want to change the mission now when we have a proven instrument, a proven complement. We can build it again with reliability and with an accurate cost and schedule.

Mr. BABIN. Thank you. And thank you, Mr. Chairman. My time is expired.

Chairman BRIDENSTINE. I'd like to thank the gentleman from Texas.

We're going to move into a second round, and I'd like to start by asking Dr. Volz one of the things that came out of the GAO report has been the challenge that we've had with the Suomi NPP expected life, and now it's been extended. I don't think anybody doubts the fact that Suomi NPP is going to be around longer than the expected life at the time of its launch. I think one of the concerns we have is that the process and the procedures, the clarity for how we go about extending that life, and—from our perspective it might look like it's subjective. Can you give clarity on how you make that determination, and then maybe in the future have published standards or something that determine how we move forward so then there isn't a question about why it was changed.

Dr. VOLZ. Yes, sir, and thank you. That's an excellent point. And that was part of the dialogue we've been having with the GAO over the past couple of months about how we do our fly-out charts, how we do our projections. One case of terminology, we don't extend life. We update our analysis on the projection of probable life. We don't decide to terminate or to extend; it's whether the satellite is functioning or not. And we use our analysis, our understanding of its performance to see how far we can project that performance into the future.

So what we have done with Suomi NPP, different from our legacy satellites is from the start done statistical analysis of the instrument capabilities, the instrument performance, the spacecraft lifetime, the operations of it, how it wears out over time. And based on the information from the satellite and the general understanding of our electronic parts and hardware, in the whole aerospace industry, come up with projected probability of success or P sub S for these satellites into the future.

That is our new baseline approach for Suomi NPP, and it will be for JPSS and for our GOES satellites going forward. It was not a methodology that was applied in the previous years, so when we try and apply that same rigor to legacy satellites which don't have the basis of information that we started with, it's hard to retrofit that analysis. So we're not going to be able look at a POES satellite launch 15 years ago and apply the same rigor of analysis that we can to JPSS. We don't have the basis. But our plan is to have a transparent process for how we do this on an annual basis, how we update our fly-out charts, where the assumptions that are built into it are stated, and then we can discuss whether they're appropriate, but they're clearly stated for all to see.

Chairman BRIDENSTINE. That's great. We thank you for that. When you think about the NOAA-16 satellite that broke up randomly—and I shouldn't say randomly. It broke up. And do you have any clarity on that? And one of the concerns we had is could that same fate be the fate of Suomi NPP?

Dr. VOLZ. So given the—the answer to the first question is I don't have clarity on the exact breakup reasons for NOAA 16. It was non-communicative at the time. It had been inert for some time, so it spontaneously devolved or broke up. So we don't know the root cause. We can speculate on what they might be.

But whether it was something internal to the spacecraft or a micrometeor object debris, those effects and those risk factors are factored into our analysis of Suomi NPP. So we routinely, for example, do debris-avoidance maneuvers for Suomi NPP when we know based on our tracking that there are potential conjunctions with other debris. So we are mitigating that to the extent that we can, that we can see these objects.

As I mentioned before, the health and status, the battery life, the propulsion systems in the satellite we monitor on a regular basis, so spontaneous explosion or breakup from anything internal or tracking the engineering capabilities very carefully on the spacecraft to know whether or not that's a possibility and mitigating them if we see any effects.

Chairman BRIDENSTINE. Okay. Got it. I wanted to ask about the commercial pilot program, commercial data program. Can you give us an update where you are on that and how it's going?

Dr. VOLZ. It's going at a relatively breakneck speed. I know that may not seem like that to the commercial side, but to the government side, it is relatively quick. We have—since the—beginning of this fiscal year with the authorization for the weather data pilot, we have, as you mentioned in you, or I think Bonamici mentioned in her opening, we have released our process for evaluation. We released an RFI to the community for opportunities for provision of data for us to evaluate as part of the pilot process, and we currently have on the street a draft Request For Quotations from the commercial industry to sell data to NOAA, to NESDIS for us to evaluate radio occultation data for suitability in our use for weather modeling. We expect that to be closed in a couple of weeks. We actually have industry day this afternoon to answer questions, and the actual request will go out in early August. And our target is to have data on hand from vendors or at least under contract by the end of this fiscal year.

The challenge right now is that the available data is an empty set. There are no observing commercial systems out there now providing data that we can use. That's why we asked for an extension to fiscal year 2017. And the RFQ will actually ask for data up through April of 2017, for—anticipating the launch of these assets in the next 6 months so that we can get those data on board, pay for them, and do our evaluation process internally.

Chairman BRIDENSTINE. Got it. And then, Mr. Stoffler, the two highest priorities of course for CENTCOM—cloud characterization and theater weather imagery—there are commercial capabilities that are out there that might not be in space just yet but are planning launches as early as 2019. One of them would be hyperspectral capabilities. Would those capabilities be valuable to you for cloud characterization or theater weather imagery?

Mr. STOFFLER. You are right on the money, Mr. Chairman. Those capabilities would be very valuable to us, and we are waiting with great anticipation when that data becomes available.

Chairman BRIDENSTINE. Now, is there a way that the federal government on the Department of Defense side could partner with a commercial company knowing full well that eventually the commercial company will have customers that aren't necessarily the Department of Defense but could be the agricultural industry, could be the insurance industry or the transportation industry, shipping industry, but to signal to the markets that there is a demand from the Department of Defense for this kind of capability? Are there ways of partnering today so that we can help get this industry going?

Mr. STOFFLER. We have what's called a CRADA, a relationship with a variety of different organizations, both government and industry, which we can leverage to advance these types of capabilities. We've also done—just like NOAA has, our program office has gone out and done a request for information to see what's available out there. And as you've already indicated, our biggest issue right now is that there is nothing to buy. So we're waiting for that to happen.

Chairman BRIDENSTINE. Is it possible to do a partnership where maybe the private sector would provide the data for free to the Department of Defense? In return, the private sector would get an EELV launch or some kind of partnership like that?

Mr. STOFFLER. I'd have to speak to our acquisition agents to give you a proper read on that, sir.

Chairman BRIDENSTINE. Okay. I'd like to recognize the acting Ranking Member, Mr. Grayson, for a second round of questioning.

Mr. GRAYSON. Thank you. Dr. Volz, the 2013 NOAA, NESDIS, and NASA independent review team made several recommendations regarding the weather satellite programs and putting them on what was referred to as a robust state. Do you know what they meant by robust?

Dr. VOLZ. Yes, sir. The robust means essentially single-fault tolerant or two failures to a gap, which means you can lose any major on-orbit asset and have a second one ready to support the same mission, provide the same information content without interruption. So that would require redundant capability on orbit at the same time.

We are in that situation, for example, right now with the geostationary satellite constellation. We have two active and one is a backup for either of the two so we could lose one and a satellite could move over and give us the same coverage. We are not in that condition right now in the polar because although we have legacy POES satellites, they are not as capable and not as functioning at the capacity of the Suomi NPP satellite.

So when we look at the JPSS–1 and the JPSS–2, getting to the JPSS–2 launch so we have both J–1 and a J–2 on orbit both effectively in their prime of life, get you to that condition of robustness where you have two fully functioning satellites in their prime lifetime ready to support the mission.

Mr. GRAYSON. So robustness in this case just means having a backup, is that correct?

Dr. VOLZ. It's on orbit ready redundancy effectively, yes.

Mr. GRAYSON. All right. Apart from what you just said, is there anything else that needs to be done in order to secure that condition?

Dr. VOLZ. The robust condition, that is one approach. That is one piece of the robustness. It also requires the overall observing system is ready and available and functioning as well, which includes not only those two satellites, but as we mentioned that we have other assets in the morning orbit from the Europeans and the early a.m. orbit from the DMSP and from other partner satellites that we have a functioning ground system which is redundant and capable to handle. If we have a hurricane come through in one, we have a backup system, we have redundant antennas, et cetera.

So the overall observing system on the NOAA piece needs to be robust and reliable, and the observing system of a global system needs to be able to provide the data that we rely on. Quite frankly, our partnership with the Europeans is essential as part of our collaborative efforts going through the years. And their constellation robustness is as strong, their requirements are as strong as ours.

Mr. GRAYSON. All right. Regarding NOAA's commercial weather data pilot, what other kinds of data can you consider as being likely or possible for future acquisition?

Dr. VOLZ. When you talk about the future capabilities, there are potentially a number that are likely to be coming around in the near term that are not yet available. Chairman Bridenstine mentioned hyperspectral as one possibility. There are a number of small satellite or even CubeSat versions of sounders that are being planned or—NASA is working on launching and we're working with NASA to understand the planned capabilities there.

You look for areas where technologies are scalable to smaller size or affordable by venture capitalists or small companies and can meet our requirements. So those three factors fold in in a couple of potentially significant ways, like I mentioned, hyperspectral, microwave sounding, and additional radio occultation.

Imagery has already gone through this transition. We're not a big imagery buyer, but industry is already seeing that there are commercial applications.

Our Commercial Weather Pilot focused on radio occultation first and foremost because that was the most mature of these potentially emerging capabilities, but I fully expect that as we continue our engagement with the commercial sector, as we look at our strategic plan for the next emerging capabilities for our constellation, that there will be others who are reaching that same level of maturity that will need to be evaluated for their suitability for our measurements.

Mr. GRAYSON. So what kind of time frames are you anticipating for the other data sets?

Dr. VOLZ. For the immediate future we're focused right now on the radio occultation in the fiscal year 2016, fiscal year 2017. We are looking at options in fiscal year 2017. We've issued another call for interest on other measurements. Hyperspectral may be one, I mean, without tailoring it to specific targets seeing what else is likely to be in the market available. We are moving forward on our space weather architecture and there are potential, and have been expressed interest in providing space weather observations that could be useful as well. So these are areas in the '17 in the near-term time frame that may be viable for satisfying.

Our focus has to be on understanding the capabilities and seeing how they match our requirements and our observational needs. We are a requirements-driven organization, so we look to what our requirements are and how they can best be met. And we consider commercial emerging along with government-built as the—what would be the best match to meet our mission objectives.

Mr. GRAYSON. Can you be more specific about what time frames we're talking about, how many years out and so on?

Dr. VOLZ. Right now for radio occultation we have seen suggestions of launches in the next year. So that would mean we would be looking at data from an RO system potentially by this time next year or in fiscal year 2017 that would be ready for evaluation. For these other hyperspectral, it's more suggested, and it would depend on the maturity and the development pace of the industry itself. I would not be surprised to see something in the '18 to '19 time frame or there'll be potential demonstrations on orbit at some of these others, but it depends on sources and investments by others outside of our organization.

Mr. GRAYSON. My time is up. Thank you all again.

Chairman BRIDENSTINE. I'd like to thank the gentleman from Florida.

The gentleman from Texas, Mr. Babin—Dr. Babin is recognized for five minutes.

Mr. BABIN. Thank you, Mr. Chairman. I appreciate it.

Colonel Stoffler, one question I hear that I have for you, let me read you a portion of the national space policy signed by President Obama in 2010. The Secretary of Commerce through the NOAA Administrator, the Secretary of defense through the Secretary of the Air Force, and the NASA Administrator shall work together and with their international partners to ensure uninterrupted operational polar-orbiting environmental satellite observations. The Secretary of Defense shall be responsible for the morning orbit and the Secretary of Commerce shall be responsible for the afternoon orbit. Are you familiar with this national policy?

Mr. STOFFLER. Yes, sir, I am.

Mr. BABIN. Currently, does the DOD have a plan and money in the budget for maintaining the morning orbit? If not, why is DOD going against national policy?

Mr. STOFFLER. Sir, at this particular time we're meeting the national space policy objectives as long as DMSP continues to be in orbit. Final decisions haven't been made on weather satellite follow-on, but if we launch WSF in the morning orbit, I believe that we're meeting the objectives of national space policy.

Mr. BABIN. Okay. All right. I understand that NOAA—this is for you, Mr. Powner, I'm sorry. I understand that NOAA needs to launch the first polar satellite, JPSS–1, as well as the follow-up JPSS–2 to have a more robust system. We've mentioned earlier this morning. After that when does NOAA need to launch the remaining two satellites?

Mr. POWNER. Well, I think that's what's—currently right now I think the plan is to launch in the 2024 and '26 time frames those two satellites and then actually they would be stored for a period of time. So, for instance, J–3 I believe the current plan is to launch 2024 and to store for about 2–1/2 years into 2026. With J–4 the plan would be in early 2026 to have it ready to go in storage and launch in '31.

Mr. BABIN. Okay. Thank you. Is NOAA and the federal government actually saving money by building satellites now?

Mr. POWNER. They could be because of the economies of scale, but the—you know, you've got to offset that with some of the storage costs. We understand that is in excess of—although if you look at what happened with DMSP 20, that ended up being in excess of some of the storage costs there. Again, we've got to find what's that right area where we're building it and having this robust constellation that Dr. Volz referred to.

But also, too, you need to balance that with Congressional budgets. We know that both the GOES program and the JPSS, those two programs consume a large portion of NOAA's budget. So if in fact you could address other priorities at some point and hold off those out-year satellites, maybe that's the appropriate thing to do that—we would just like to see the analysis provided to Congress, not only this committee but we get the same questions from the appropriation committees whether this is the right cadence and sequence for the out-years satellites. And it's really in NOAA's court to prove that that is the best cadence with those out-year satellites.

Mr. BABIN. Okay. And then one more question for Dr. Volz in regard to the SNPP and the ATMS instrument onboard, if the ATMS instrument fails on SNPP, what would be the backup for its measurements until JPSS–1 is operational?

Dr. VOLZ. We have no immediate backup in orbit for the ATMS. However, for the observing system requirements, ATMS is one of a number of observations. You asked the question earlier what does the loss of one satellite mean, and we can get back to that specific answer. The loss of one instrument on one satellite has an impact as well, but the system itself has multiple observation points that are brought in that are used as part of the numerical weather forecasting modeling. I don't have the exact result to tell you what the specific impact would be for the loss of ATMS. I can get that back to you. We've done these studies in the past.

But the overall observing system, as we've talked about already here, relies on multiple observations from multiple points, so the loss of any particular asset, while unfortunate, doesn't derail the entire observing system. It's an impact that has to be absorbed if we don't have a backup for it in place at the same time, which is the point of getting to the robust as quickly as we can.

Mr. BABIN. Thank you, Dr. Volz, and I'll——

Chairman BRIDENSTINE. The gentleman yields back.

Mr. BABIN. Thank you.

Chairman BRIDENSTINE. Thank you, Dr. Babin.

We'll go into a third-round as long as people are sticking around. You're not—well, I'll ask a few questions then if that's all right.

I wanted to bring up a couple of challenges that we've seen within the Department of Defense and how we've applied some solutions in the Department of Defense when it comes to the space-based communications, for example. We now lease about 80 percent of our communications over the horizon from commercial assets.

Now, that does a number of things for us. Chief among them, it gives us the capacity and the throughput necessary to get the information and the high-resolution, motion picture imagery from the place where it is to the place that it needs to go. That's number one. But number two, it also distributes the architecture very rapidly in a way where it complicates the targeting solution for our enemies. And of course we've seen the Chinese and the Russians both advanced anti-satellite directive-sent missiles, which are of concern to those of us on this committee and on the Armed Services Committee. What—so that partnership that we have with commercial industry to do over-the-horizon indications I think is very valuable.

We've also seen for narrow-band communications, we've seen the success of Iridium, which was a partnership between the Department of Defense but also international partners, and it was, you know, provided—financing initially for Motorola, but eventually there was financing from a venture capital kind of capability that came together. And now the Department of Defense is using Iridium very robustly around the world.

I would also say when it comes to remote sensing and imagery, we've seen the National Geospatial-Intelligence Agency move forward on a commercial space policy where they're buying imagery from space from commercial operators and they're going to continue to do that. Again, it complicates the targeting solution for the enemy by distributing the architecture, and it also gets us more data, better data, higher revisit times, things like this.

Are there partnerships like that when you think about defense weather? Could we develop a partnership similar where maybe we have a satellite bus and we attached to it payloads that are necessary for cloud characterization or necessary for theater weather imagery? And in this era of defense sequester, which is damaging our Department of Defense, create more robust partnerships that would be good not only for the Department of Defense in bringing down costs because when you purchase from commercial, you ultimately have more customers than just the Department of Defense, which shares the cost but also distributes the architecture?

Mr. Stoffler, could you comment? Are you guys having those kind of conversations about bringing down cost, distributing the architecture, and ultimately getting more data, better data, and higher revisit times?

Mr. STOFFLER. I appreciate that question, Chairman, and again, you're right on the money. We are indeed going down that path-way. The first example of that is already what we're doing with gap 11. We're going to build a very small space weather, and instead of sticking it on to one big huge weather satellite, we're going to add that particular sensor to all future Air Force satellites. So by using disaggregation and placing individual weather sensors onto existing satellites, I think we can get a better picture, a higher refresh rate, and bring down overall costs and of course have more resiliency in the constellation as well.

Chairman BRIDENSTINE. Could you host those sensors on commercial payloads that would even give us more opportunities to launch, more opportunities to put those sensors in space?

Mr. STOFFLER. I would be inclined to say that you probably could, but again, it would be to our acquisition experts to make that determination.

Chairman BRIDENSTINE. Okay. One other challenge that I see ahead of us, being from Oklahoma, on these issues I don't really have any parochial interest, other than the fact that I have constituents that die from tornadoes. My mission here is to get as much data, the right data so that we can ultimately move to a day where we have zero deaths from tornadoes.

Now, I know what we're talking about generally here is the macro scale global initial conditions for weather forecasting, but my concern is that as we go forward with a commercial capability, we're going to have a lot of data. And when you think about hyperspectral, when that capability comes online, there's going to be a lot of data. One of my concerns is how do we assimilate all that data into our models? Is that possible now? What do we need to invest in? How can this committee be helpful?

Mr. Stoffler, I'll start with you and then will go to Dr. Volz.

Mr. STOFFLER. Again, a very critical question, and I appreciate that, Mr. Chairman. Certainly on the DOD side we recognize that. We have developed an architectural design to revamp our entire computing system to increase computing capacity, remove legacy systems. We're going to a 4D–Var assimilation scale, and we certainly believe that by the 2021 time frame our new architecture will be able to do all the things that you've addressed.

Chairman BRIDENSTINE. And do we need additional modeling capabilities? Do we need additional computing capacity? Are you saying that you're good and you have everything you need to move out?

Mr. STOFFLER. I think from an Air Force perspective we've developed the plan. The Air Force has been very supportive, and we're on path by 2021 to meet our objectives.

Chairman BRIDENSTINE. Dr. Volz?

Dr. VOLZ. I think you pinpoint the exact challenge we have is that we're in an age of explosion of data availability, and the utilization of it effectively is going to be our greatest challenge. And it's not just satellite data. It's incorporating and merging satellite data with in situ ground data, airborne data to get a better holistic pitcher of what's going on. And I think it's always going to be— we're always going to be running uphill on this and trying to get greater computing power. As we bring in more data, as we simulate more data sources, the challenges are going get more and more challenging.

So even though at this point we've come a long way in the past three years with our high-performance computing within NOAA and it's enabled us to ingest other data sources as part of our gap mitigation efforts to support the polar constellations, but now with the launch of GOES–R coming on in just a few months, which is going to have a significant—60-fold increase in the data rate that we see from now-casting, how we integrate those data sets into the weather forecast on modeling in the offices is going to challenge us as well.

So there will always be need for incremental and sometimes leaps-forward steps in high-performance computing and the modeling to ingest these new data sets. So I would never be comfortable saying we're good where we are now. We are using what we have, but we're always trying to figure out how to bring these other data sets in more efficiently and more effectively. It's going to be an ongoing challenge for as long as we're working on this.

Chairman BRIDENSTINE. Excellent. Earlier, Mr. Stoffler mentioned that the Department of Defense is not going to accept data from the Russians or the Chinese. Does NOAA have a position on that?

Dr. VOLZ. NOAA does not use Russian or Chinese data in our modeling and in our forecasts. We work with the scientific community, with the academic community. Where the data are available through our international partnerships, where the data are available for assessment and analysis, and we are working with our academic partners to understand the capabilities. And they are getting stronger and better. So there is enticing the availability or the quality of the data that are available. We are not at this time using them as part of our primary products and services.

Chairman BRIDENSTINE. But there's not a policy position that says we won't use them?

Dr. VOLZ. I don't know if there is or not.

Chairman BRIDENSTINE. Okay.

Dr. VOLZ. We're not using them at the moment. I do not know what the official policy might be on this.

Chairman BRIDENSTINE. Okay. I'd like to yield to the acting Ranking Member, Mr. Grayson from Florida.

Mr. GRAYSON. Dr. Volz, the May GAO report reviewed NOAA's basis for initiating work on the polar follow-up satellites on the basis that they wouldn't actually be put into use for a decade or more. What is the agency's position with regard to the GAO's recommendations and their observations?

Dr. VOLZ. There are a number of observations in their report, and I think Mr. Powner has talked about the challenge of building efficiency versus developing stale satellites which sit around for a long time. And we've look very carefully at the lessons from our own POES and from DMSP of how long those satellites should be in storage and how much you want to be able to refresh technology.

And I think the point was made that we need to show how our plan is robust and appropriate mixture of stability and requirements but also efficiency and production and procurement. So I believe that the approach that we have as we're going through this year, this calendar year of the final program review of what the approach would be for the launch cadence, for the launch development cadence for the PFO instrument satellites will address those questions.

I think what we have is we're doing two things at once. We're building at the most effective price-wise point to build these satellites, but we're also building to get to that robust constellation as quickly as we can. It only takes one launch failure to disrupt an entire plan of what your launch cadence should be. So we want to be able to have a satellite in storage and ready when we need it, but we don't want to have it sitting in storage for 20 years.

I think we've got the right balance in the way that we've built and we plan on testing and storing the satellites, again, taking lessons from other satellite histories to do this appropriately for the JPSS PFO program.

Mr. GRAYSON. When we launch a satellite today, are we putting in the same instruments and sensors that we put in 10 or 15 years ago?

Dr. VOLZ. No. The JPSS and the GOES–R satellite series are leaps forward in capabilities and instrumentation. It is the next generation, particularly for the GOES that we're seeing in the launch this fall. JPSS is leveraging the instruments that were developed in a research basis for the Suomi NPP satellite, which was launched in 2011. The JPSS–1 through 4 satellites will have those same instruments, so there is effectively consistent performance and observations set that we will have for the next 20 years from those four satellites. GOES–R will have a similar 20-year period from '16 to the mid-'30s.

That doesn't mean our observing system is stagnant at that point. We've talked about all these other emerging capabilities, the other international partnerships that are bringing their satellites in for the commercial side. That backbone of those foundational measurements that are going to get from JPSS and GOES complement and support the other measurements that come in. And then we have the challenges that Chairman Bridenstine just mentioned of merging those different data to an integrated system which provides a much more holistic and higher-quality understanding of the environment that we're trying to provide.

Mr. GRAYSON. Well, if we're using dramatically different instruments and sensors than we did 15 years ago, doesn't it follow that we'll want to do the same thing when we do a launch 10 or 15 years from now when we basically have to completely revise the guts if you will of the satellite before it's going to have full functionality for launching 10 or 15 years from now?

Dr. VOLZ. Excellent point in that what we're launching in 15 years from now or 20 years from now is the next generation following what we have right now. So we are in the process right now of starting a next-generation mission assessment and development, our architecture studies of what should be the leap after JPSS and GOES–R. There's a generational cycle of major performance upgrades, and whether it's 10 or 20 years, it's 20 years roughly where you have that basis where you get used to using those instruments where all the modeling and all the forecasters are using them, and you add incrementally from other satellite observations increased capacity.

And then, as we have this basis for JPSS, we are now looking at what should be the thing that follows, launching in the 2030s. And we'll do that with testing and demonstrations with commercial satellite examples, with NASA research and other research satellites that are demonstrating capabilities. And we'll be able to pick from those on-orbit experiments the best step forward as opposed to just sitting in an a priori position, saying I know what it should be. We get to demonstrate with these research satellites and with the commercial side to then decide what's the most effective path forward for the backbone of the next generation, which will be launching in the mid-'30s.

We will start building that in the next few years, but we won't deploy it until after these four satellites, this constellation is gone.

Mr. GRAYSON. Well, to be as specific as possible, did the agency assess the likelihood that the polar follow-on satellites would have to be—how shall I put this—updated before being put into actual use, having been built now with technology developments coming in the next decade or decade and a half? And if so, what was that assessment and how much do you think it might cost?

Dr. VOLZ. Yes, we did, and we actually made a conscious decision a year ago, as we rolled out the plan for the PFO, that we would hold the requirements baseline for the PFO JPSS–3 and 4 satellites to the same standards we set for JPSS–1 and 2. We did that consciously aware of exactly the point I think that Ms. Chaplain mentioned is that when you change requirements on the system in the middle, you're basically developing a new system and you lose all control of your cost and schedule. We made that conscious decision that this suite of four satellites would be consistent, and we have now the contracts in place for the spacecraft, for all the instruments so that we can accurately project and deliver those instruments.

But the system evolves, and the system then brings other capabilities in addition to the JPSS. So the overall capability of observing is going to increase and improve over time, but this portion of it is going to be stable, and the funding and the requirements will be well defined and well characterized.

Mr. GRAYSON. I'm out of time. Thank you all.

Chairman BRIDENSTINE. I'd like to thank the gentleman from Florida for his, quite frankly, great questions. I think you're hitting on a critical thing that we need to be talking about on this committee, and that is technology insertion plans. One of the reasons I think commercial is so important—and I want to be really clear. I support JPSS. I want to make sure JPSS is fully funded, but I do believe commercial is important because commercial satellites are being launched with miniaturization of technology, miniaturization of electronics. We're going to be able to launch a lot more satellites in more distributed architectures that again complicate the targeting solution for the enemies but also with smaller satellites you can launch more of them, you can launch them more frequently. When you have new technologies that arise, you can put them in orbit very rapidly.

I would also say one of the areas that I've been pushing on is the hosted payload concept where every time a commercial communications satellite launches, we could test a new sensor on that commercial communications satellite, and those satellites are launching quite frequently these days. And not only in geostationary orbit but now in the future we're going to be launching them into low-Earth orbit as well.

I'd like to recognize the gentleman from Texas, Dr. Babin, for the final five minutes.

Mr. BABIN. You bet. Thank you, Mr. Chairman. I just had one question for Mr. Powner concerning the fly-out charts and schedules annually published by NOAA. Do they accurately depict the state of our satellites in orbit, these fly-out charts?

Mr. POWNER. Yes, I think the fly-out charts, there's improvements that could be made. So for—I'll just point to NPP. The NPP, the amount of fuel that's on there, that's not what's really important. What's important is how long is the spacecraft and the sensors going to last? And we think those fly-out charts should reflect that.

I think Dr. Volz brought up some good things with their availability assessments. They have the data. That data, when you look at the 2015 analysis, basically says that I think—I think the life span using their data is somewhere in the 2018 time frame, not 2020. However, that's dated.

And I do want to bring up this point on ATMS again because I think Dr. Volz is right. His answer was absolutely correct that all this data plays into the short-term forecast. But let's not downplay the importance of ATMS and CrIS and the importance of using those two instruments together for forecasts. If you don't have ATMS working well, there is an effect on our forecasts, so it's very important that we keep that thing going on NPP until we get J–1 up there.

Mr. BABIN. Okay. Thank you. Why is NOAA fiddling with the estimated life span? Is it to make it appear that we are not facing a data gap?

Mr. POWNER. We've had great debates over this data gap over the years, Congressman, and, you know, in our—we put it on our high-risk list, the gap—potential gap in the data here is something that is critical. We need to acknowledge it. We need to have appropriate contingency plans in place. I think NOAA has done a good job on that, but I think there needs to be even better transparency with these fly-out charts and everything, not only this committee, but we get the same questions from the appropriators, too. It's not always clear.

Mr. BABIN. Yes.

Mr. POWNER. And we just need better transparency. And I think we're moving in that direction, and I think there's been an acknowledgment of that.

Mr. BABIN. Okay. Mr. Chairman, that's all I had this morning. And thank you, witnesses, too. Thank you. I yield back.

Chairman BRIDENSTINE. Well, thank you. I'd like to thank the witnesses for their valuable testimony today and the Members for their great questions. The record will remain open for the next two weeks for additional comments and written questions from Members. This hearing is adjourned.

[Whereupon, at 11:38 a.m., the Subcommittee was adjourned.]

Appendix I

ANSWERS TO POST-HEARING QUESTIONS

ANSWERS TO POST-HEARING QUESTIONS

Responses by Dr. Stephen Volz

Committee on Science, Space & Technology

"Examining the Nation's Current and Next Generation Weather Satellite Programs"

Questions for the Record to:
Dr. Stephen Volz, Assistant Administrator for Satellite and Information Services, NOAA
Submitted by Ranking Member Suzanne Bonamici

Question 1a: According to reports, the Suomi NPP ATMS scan drive system has experienced anomalous current spikes due to premature wear of the mechanism bearings. Although NOAA has implemented periodic scan reversals to mitigate wear and redistribute lubricant, the current spikes have persisted. If the ATMS instrument aboard the Suomi-NPP satellite were to fail due to these current anomalies, or for any other reason, how would the loss of ATMS data impact the accuracy of NOAA's weather forecasts?

Response 1a: The Suomi NPP observatory will achieve its design life in October 2016. While the satellite has started to exhibit signs of age with the Advanced Technology Microwave Sounder (ATMS) scan drive mechanism wear, this has not resulted in degradation of the science data in support of National Weather Service (NWS) numerical weather prediction (NWP) modelling. All the Suomi NPP instruments are supporting NWS weather and NOAA environmental monitoring requirements. Currently, the polar-orbiting satellite component of the Global Observing System has three orbital planes (the early morning, mid-morning, and afternoon orbits) that are all occupied by satellites that provide microwave sounding data. Specifically, there are:

- **Early morning orbit:** The primary satellite is the Defense Meteorological Satellite Program (DMSP) Flight 17 deploying the Special Sensor Microwave Imager/Sounder (SSMIS). NOAA legacy satellites, NOAA Polar Operational Environmental Satellites (POES; NOAA-15) which has the Advanced Microwave Sounding Unit (AMSU) onboard is providing back up service.

- **Mid-morning orbit:** The primary satellite is EUMETSAT's Metop B, with the legacy satellite, Metop A, providing back up service. Each Metop satellite is flying the Infrared Atmospheric Sounding Interferometer (IASI) sounder, and a NOAA-provided AMSU sounder.

- **Afternoon orbit:** The primary satellite is NOAA's Suomi NPP which has the ATMS and Cross Track Infrared Sounder (CrIS) instruments onboard. The legacy NOAA POES (NOAA-18 and NOAA-19) with the AMSU, and NASA's Aqua platform with the hyperspectral Atmospheric Infrared Sounder (AIRS) instrument.

Global NWP models run every 6 hours and require global observations for every 6 hour cycle to achieve the operational forecast skill upon which the NWS depends. At a minimum, two polar orbits are required to achieve ~90 percent coverage every cycle.

To date, NOAA has not conducted data denial studies showing the impact from the loss of the ATMS instrument specifically. NOAA studies have shown that NWP model forecast skill is degraded (i) slightly if observations from only two of the polar orbits are available instead of three, (ii) strongly if observations from only a single polar orbit are available, and (iii) severely if there are no polar satellites providing data at all. Losing the early morning orbit will have the least impact since the microwave instrument on the DoD satellite is marginal for NWP.

The biggest risk of operating with only two polar orbits, *i.e.*, EUMETSAT mid-morning and NOAA early afternoon orbit, is that if that a gap occurs in either of those orbits, NWP skill would be severely impacted.

Question 1c: How would NOAA mitigate the loss of ATMS data prior to the launch of JPSS-1?

Response 1c: If the ATMS on Suomi NPP were to fail prior to the launch of JPSS-1, NOAA's mitigation plan would include continuing to rely on the soundings provided by CrIS on Suomi NPP, as well as the sounders currently in orbit on the NOAA and non-NOAA polar satellites. The mitigating assets, with the exception of Metop B and Suomi NPP, are all operating beyond their design life. While NOAA assimilates some DMSP data, the EUMETSAT mid-morning and the NOAA Suomi NPP early afternoon orbits are the critical sources of data for NWS NWP models.

Looking beyond 2020, having a stand-alone sensor, such as Earth Observing Nanosatellite-Microwave (EON-MW) within the Polar Follow On (PFO) program available to provide microwave sounding data in the event of the loss of one of NOAA's afternoon polar orbiting satellites, as requested in the FY 2017 President's Budget, is expected to significantly reduce the resulting loss of NWP skill due to a loss of ATMS data.

Further, having a robust radio occultation constellation which would be comprised of equatorial and polar-orbiting data such as what NOAA plans with the Constellation Observing System for Meteorology, Ionosphere, and Climate (COSMIC-2) constellation and eventually with commercial data sources will complement and enhance other existing data sources, partially mitigating the loss of ATMS should that occur.

Question 2: Please describe how NOAA estimates the expected useful life of its satellites. How often are these projections revised and what data is used to justify such revisions? How does NOAA keep the public apprised of its satellite lifetime projections?

Response 2: For new satellite designs, NOAA specifies a contractual requirement for design life. The requirement for a specified design life influences many design features of a satellite.

After launch, NOAA operations personnel perform regular health and status monitoring for satellites under their command and control. A key metric used to estimate on-orbit lifetime is fuel consumption. NOAA operations personnel continuously monitors the health of the instruments and spacecraft along with estimated-versus-actual fuel consumption for the GOES-NOP and Suomi NPP satellites in order to make predictions of fuel-limited mission life.

The JPSS/PFO and GOES-R Series satellites will transmit more health and status data, which will enable more complete availability assessments.

For older spacecraft without maneuvering capability (NOAA-15, -18, and -19), lifetime assessments are based purely on the projected health of the spacecraft and instruments as assessed by NOAA's spacecraft engineers.

Real-time status of all NOAA on-orbit satellites is posted on the operational web pages. For geostationary satellites, see http://www.ospo.noaa.gov/Operations/GOES/status.html. For Polar-orbiting satellites, see http://www.ospo.noaa.gov/Operations/POES/status.html. The results of lifetime estimates are shown on NOAA's geostationary and polar flyout charts: http://www.nesdis.noaa.gov/flyout_schedules.html.

Question 3: Please explain the importance of communication between NOAA and DOD as it pertains to the weather satellite programs. What concrete steps can be taken to improve such communication and coordination?

Response 3: NOAA and DoD have a decades-long history of communication and cooperation at all levels of both organizations for acquisition programs, operations, and research for terrestrial and space weather. In the recent past, Department of Commerce, NOAA and DoD leaders have re-invigorated regular dialogue to coordinate and exchange information that would benefit and strengthen an overall U.S. civil-military Earth Observation posture. For example, NESDIS Assistant Administrator has continued his predecessor's practice of quarterly dialogue with the commander of the U.S. Air Force Space and Missile Systems Center and has expanded dialogue to include various Pentagon counterparts. These senior-level dialogues enhance the excellent dialogue and operational cooperation at many levels of both agencies. This dialogue is based on the strong partnerships at the program and project levels. Major examples include:

Operations: NOAA has been operating the DMSP spacecraft for over 20 years and the U.S. Air Force has staffed an operating location in support of the DMSP program at the NOAA Satellite Operations Facility (NSOF) in Suitland, Maryland. Both agencies will continue to support this effort through the end of life of the last DMSP spacecraft. The Joint Space Operations Center (JSpOC) provides comprehensive space domain awareness and conjunction warning support for NOAA's entire fleet of weather satellites and those of our European mission partner. In addition, NOAA and the DoD collaborate on satellite contributions to the U.S. Navy's oceanographic mission. NOAA, the U.S. Navy, and the U.S. Coast Guard jointly operate the National Ice Center which is located at the NSOF. NOAA's Cooperative Data and Rescue Services (CDARS) Program is currently planned as a hosted system using the U.S. Air Force Hosted Payload (HoPS) contract mechanism. The CDARS Program will provide operational continuity to the satellite-assisted Search and Rescue, a service that is used by all DoD services and millions of civilian users, and the Argos Data Collection System which provides tracking capabilities for environmental monitoring and wildlife tracking. NOAA, the U.S. Navy and U.S. Air Force exchange significant amounts of data through shared services agreements. This data sharing allows NOAA access to DoD acquired data, and DoD access to data NOAA receives from its observation platforms and from partnered platforms.

Acquisition: We have been coordinating efforts on launch of the next generation of the COSMIC-2, a follow-on joint collaboration between U.S. Government agencies and Taiwan. The U.S. Air Force is providing six Radio Occultation (RO) sensors and the launch vehicle for COSMIC-2A, which will be in an equatorial orbit. NOAA also partnered with DoD on the Deep Space Climate Observatory (DSCOVR) spacecraft program, which culminated in a successful U.S. Air Force-provided launch vehicle.

Research: NOAA and the DoD have had frequent dialogue concerning mutual use of hosted payloads. NOAA's Total Solar Irradiance Calibration Transfer Experiment (TCTE) is presently operating as a hosted payload on the U.S. Air Force's STPSat-3 spacecraft. NOAA, NASA, and DoD participate in the Joint Center for Satellite Data Assimilation, a joint effort to maximize the utility of data from civil and DoD Earth Observation satellites. DoD and NOAA have collaborated in exploring material and nonmaterial options to meet critical DoD meteorological and oceanographic capability gaps in cloud characterization and theater weather imagery.

All of these activities are based on years of collaboration and cooperation that strengthens U.S. civilian and military uses of Earth Observation data.

Question 4: Please describe the analysis NOAA performed to inform the development strategy for the JPSS and JPSS Polar Follow-On programs.

Response 4: NOAA compared several acquisition approaches before deciding on the strategy selected for the JPSS and PFO. After the tri-agency National Polar-orbiting Operational Environmental Satellite System (NPOESS) was terminated in February 2010, NOAA was responsible for continuity of data in the afternoon orbit. The Suomi NPP mission had been originally conceived as an NPOESS risk reduction mission and was designed to standards acceptable for a research mission. The Suomi NPP flight and ground system were designed for a research environment and did not have the necessary security posture or redundancy that an operational system required.

Assuring continuity also necessitated accepting the built instruments and parts from NPOESS management regime that were different from NOAA-NASA accepted standards to form the JPSS-1 mission instrument suite. As a risk reduction measure for the JPSS-1 mission, NOAA and NASA decided to procure a near-clone of the Suomi NPP spacecraft bus for JPSS-1. NOAA assessed the overall risk of Suomi NPP and determined that it would accept them and has been using data from the Suomi NPP in its operations.

FY 2012 appropriations allowed the JPSS program to implement its acquisition strategy to ensure active management of cost, schedule, and technical risk. The JPSS program used this funding stability to establish the program baseline in FY 2013.

During FY 2012 and early FY 2013, the lessons learned from the NPOESS experience were included in extensive analyses to evaluate instrument manifest and design changes and spacecraft configuration changes. These changes required assessment of a range of procurement approaches for the JPSS program. FY 2012 appropriations that allowed the JPSS program to implement its acquisition strategy to ensure active management of cost, schedule, and technical risk. The JPSS program used this funding stability to establish the program baseline in FY 2013

The PFO acquisition strategy includes launch dates that achieve a robust constellation as soon as possible. A robust system has two characteristics. First, single fault tolerance - two failures must occur to create a gap in the ATMS or CrIS sounding data from the afternoon polar orbit. This requires at least 2 satellites in the afternoon polar orbit with the ability to deliver ATMS and CrIS observations. Seccond, the ability to return to single fault tolerance within 1 year, if it is lost; this requires one satellite carrying ATMS and CrIS on the ground, which can be ready to launch within 1 year. Based on the FY 2017 President's Budget, NOAA will reach this second condition by Q3 FY 2022, which is a year before the JPSS-3 contingency mission Launch Readiness Date.

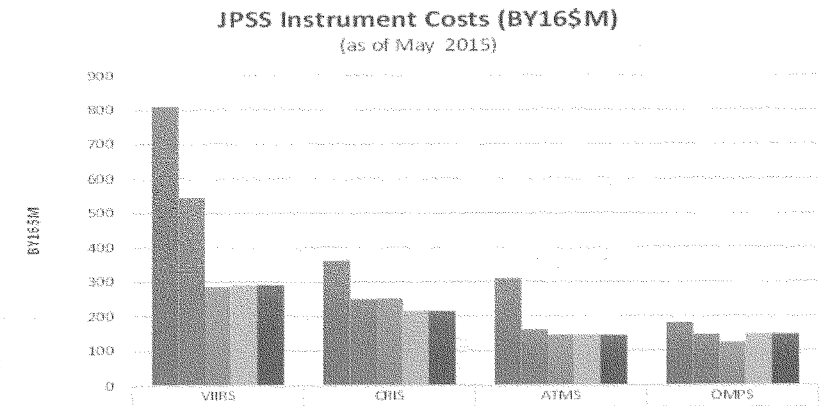
Alternative approaches for how to procure instruments were assessed and NOAA determined that the lowest schedule, lowest cost, least risk approach was to leverage the existing instrument contracts from the JPSS program to procure the PFO/JPSS-3 and JPSS-4 instruments. Because instruments have historically driven the program's schedule, NOAA is procuring PFO/JPSS-3 and -4 instruments as a single contract action (block buy) and focusing early year funding on those instruments. In addition, NOAA is procuring the PFO/JPSS-3 and -4 spacecraft as fixed-price options on the JPSS-2 spacecraft, and has established a NASA launch services strategy with schedule flexibility. The acquisition of PFO (JPSS-3 and JPSS-4) as two additional copies of JPSS-2 started in FY 2016.

These decisions will result in a robust constellation, as well as cost savings compared to other acquisition approaches. NOAA uses the acquisition experience and costs to find ways to reduce costs in satellite development and operation. NOAA takes advantage of efficiencies in the production cadence, as well as lower risk for parts obsolescence and the availability of specialized labor to reduce cost and risk. While building satellites ahead of the planned launch dates requires additional storage costs, these are typically outweighed by the simultaneously procuring multiple copies of the same the design, i.e., a block buy approach. NOAA has documented the benefits of this approach with our acquisition strategy. Therefore, PFO's flight segment will cost less than its predecessor, JPSS, and less than an approach where the satellites are procured one at a time.

Question 4a: What cost savings, if any, does NOAA anticipate will result from building JPSS-3 and -4 to be ready for launch 2 and 5 years ahead of their scheduled launch dates?

Response 4a: NOAA's decision to use a block buy approach for the PFO/JPSS-3 and -4 instruments will result in cost savings compared to other acquisition approaches. Block buys allow the buyer to take advantage of efficiencies in the production cadence, as well as lower risk for parts obsolescence and the availability of specialized labor. While building satellites ahead of the planned launch dates by two and five years requires additional storage costs, these are outweighed by the advantages offered by block buy approach.

NOAA is using actual costs expended with the NPOESS and JPSS programs to estimate costs and timelines for PFO. The PFO satellites will benefit from the experiences and lessons learned from developing the Suomi NPP, JPSS-1, and JPSS-2 satellites. The majority of the non-recurring engineering costs for ATMS, CrIS, Ozone Mapping and Profiler Suite-Nadir and -Limb, and Visible Infrared Imaging Radiometer Suite were incurred during the development of the instruments that are currently flying on the Suomi NPP satellite. The instruments on JPSS-1,-2 and PFO/JPSS-3 and JPSS-4 are essentially copies of the Suomi NPP instruments, with the only design or hardware changes are driven by significant performance or production issues identified during the development or operation of the initial units. The figure below illustrates the cost savings that are being realized with block buys.



	VIIRS	CRIS	ATMS	OMPS
NRE/S-NPP	809	362	309	179
JPSS-1	544	248	158	145
JPSS-2	285	251	144	122
PFO/JPSS-3	291	214	143	146
PFO/JPSS-4	291	214	143	146

ref: JPSS 2014 POE v2.1b, 2014 PFO v2.2

NOAA is in the process of updating the PFO Program Office Estimate (POE), but estimates that the PFO flight segment development cost (JPSS-3 and JPSS-4) will be lower than the same costs for the JPSS Program (JPSS-1 and JPSS-2) as well as lower than the "buy one at a time" approach, using constant year dollars. A more complete estimate of savings will be available when the PFO Program is baselined in early FY 2017 and will be made available to the Committee.

Question 4b: What are the risks and benefits to keeping the instrument requirements for all five JPSS satellites?

Response 4b: Based on experience with NOAA POES, NOAA believes keeping the instrument requirements relatively similar for all five satellites is an acceptable risk. By having stable requirements, the NWS weather forecasting system can rely on having access to data that it systems are optimized to ingest. The benefits of maintaining requirements are substantial cost savings for NOAA and its customers by avoiding non-recurring engineering costs and allowing for a block buy approach, as explained above. The inability for programs to control growth in requirements was described by Ms. Chaplain in the hearing when describing part of the problem with NPOESS. By maintaining the same instrument suite, NOAA is able to provide long-term continuity of observations to ensure a consistent, well-calibrated, traceable stream of the same critical data for the NWP Global Forecast System and other models that depend on these observations to enable protection of lives, property, and economic efficiency.

The risk of keeping the instruments the same for the five JPSS satellites is a lag in infusing new technology as it becomes available, resulting in the need for a major technology refresh. As has been the practice, NOAA will ingest and leverage promising data from NASA and other research satellites, or from commercial sources to test new advances. For example, while the NOAA POES satellites had been stable source of data for NWS weather forecasting, NOAA began leveraging high resolution data from EUMETSAT and NASA EOS satellites into its systems. This data allowed NWS forecasters to continue to develop forecast products using proven, operational data sources while also working with new data and technology side-by-side.

Question 4c: How does NOAA plan to take advantage of new technologies that may arise before next generation satellite designs come online?

Response 4c: NOAA has had a long practice of ingesting and leveraging new technologies and other data sources meet NOAA's operational data requirements. For example, while the NOAA POES satellites had been stable source of data for NWS weather forecasting, NOAA began leveraging high resolution data from EUMETSAT and NASA EOS satellites into its systems. These systems allowed NWS forecasters to continue to develop forecast products and working with new data and technology side-by-side. When the Suomi NPP data became available, forecasters were ready to embrace the advances that higher resolution data provided. Similarly, for space weather, NASA developed and launched a number of space weather missions that provided data that NOAA researchers were able to use to develop forecast and warning products. Eventually, the NWS stood up the Space Weather Prediction Center, NOAA added a Solar XRay Imager to its GOES and POES satellites and leveraged data from the NASA assets. Today, NOAA has stated an operational mission for meteorological and space weather.

Looking to the future, NOAA is seeking to be more agile in its ability to leverage emerging technologies and utilize them to meet its operational data requirements. The NOAA Satellite Observing System Architecture Study is looking at innovative ways that NOAA can employ emerging technologies in future satellite architecture.

There are numerous avenues that allow NOAA to benefit from the technology marketplace as a potential cost effective solution while keeping NOAA's requirements bounded. For example, NOAA is collaborate frequently with the NASA Earth Science Technology Office as well as NASA's Earth Venture missions, which make use of developmental remote sensing approaches. NOAA also leverages international partner data that incorporate advanced technology into its data streams and products, and examines the cost, benefit, and utility of commercially provided data.

As part of NOAA's strategy to achieve satellite constellation robustness by 2023 for maintaining continuity of polar satellite observations, NOAA plans to begin development of EON-MW. EON-MW is a miniature microwave sounder that approximates the atmospheric profiling capabilities of the ATMS instrument. NOAA is collaborating with the Massachusetts Institute of Technology's Lincoln Laboratory on EON-MW, which includes 2 years of risk reduction efforts to further define the EON-MW mission and identify and manage key technical risks.

Similar to EON-MW, NOAA is also exploring the potential to mitigate against the loss of CrIS data with a CubeSat based mid-wave infrared sounder. If this concept appears viable, NOAA will seek to fund and collaborate with NASA's Jet Propulsion Laboratory (JPL) to design the Earth Observation Nanosatellite-Infrared (EON-IR), which will leverage the JPL CubeSat Infrared Atmospheric Sounder mission.

In addition, NOAA is looking to use data from the NASA Cyclone Global Navigation Satellite System, currently set to launch on November 21, 2016, with plans to demonstrate assimilation of mission data into NOAA systems. NASA's new Earth Venture award called Time-Resolved Observations of Precipitation structure and storm Intensity with a Constellation of Smallsats will observe atmospheric properties in tropical cycles with 12 cubesats. NOAA sees this recently announced mission could be a pathfinder for potential future sounding missions that could meet NOAA's operational data requirements.

Finally, as the commercial sector begins to demonstrate new technologies and capabilities that NOAA could use to augment its data requirements, NOAA will be open to entering into data purchase agreements to gain access to data that has been proven useful.

Question 5: Please describe the status of the Block 2.0 upgrade to the JPSS ground system.

Response 5: The Block 2.0 upgrades for the JPSS ground system development are fully deployed and there have been no major individual test failures. However, the volume and complexity of the full scope of performance testing, requirements verification, and "de-bugging" have resulted in schedule performance being slower than planned. Based on both recent flight system issues and ground system readiness testing performance, we have directed NASA to release the January 20, 2017 launch date and requested an interim planning launch date of March 16, 2017. A firm launch date will be determined in late September 2016 after a thorough review of the entire mission.

Question 5a: Does NOAA still anticipate a 60-day overlap of operations between Block 2.0 and Block 1.2 as originally planned? Why is this period of overlap important?

Response 5a: Yes, NOAA still plans for the 60 day overlap of operations between Block 2.0 and Block 1.2. This period of overlap is important because the user interface changes between

Block 1.2 and 2.0 are significant and this overlap helps to minimize risk and impact to users. We plan to transition users over 30 days, and have the remaining 30 days as margin for uncertainties in the transition process.

Responses by Ms. Cristina Chaplain

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U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
Subcommittee on Environment

Hearing Questions for the Record
The Honorable Jim Bridenstine

Examining the Nation's Current and Next Generation Weather Satellite Programs

Questions for Ms. Cristina Chaplain

1. **In light of the lack of coordination between DOD and NOAA you highlighted in your testimony and answers before the subcommittee, do you believe a National Executive Committee for weather would help improve coordination across the federal government?**

A National Executive Committee could be a way to address the coordination problems that have existed between agencies acquiring weather satellites and potentially enhance coordination within the broader user community and other nations. There is one already in place for positioning, navigation and timing systems (primarily, the Air Force's Global Positioning System, or GPS). The 2004 U.S. Space-Based Positioning, Navigation and Timing (PNT) policy established a coordinating structure to bring civil and military departments and agencies together to form an interagency, multiuse approach to program planning, resource allocation, system development, and operations. The policy also encourages cooperation with foreign governments to promote the use of civil aspects of GPS and its augmentation services and standards with foreign governments and international organizations. As part of the coordinating structure, an executive committee advises and coordinates among U.S. government departments and agencies on maintaining and improving U.S. space-based PNT infrastructures, including GPS and related systems. The executive committee is co-chaired by the deputy secretaries of the Department of Defense (DOD) and Department of Transportation (DOT), and includes members at the equivalent level from the Departments of State, Commerce, Homeland

Security, the Interior, and Agriculture; the Joint Chiefs of Staff; and the National Aeronautics and Space Administration.

Through this structure, the departments and agencies have various assigned roles and responsibilities. For example, the Secretary of Defense is responsible for the overall development, acquisition, operation, security, and continued modernization of GPS. The Secretary has delegated acquisition responsibility to the Air Force, though other DOD components and military services are responsible for oversight, for some aspects of user equipment development, and for funding some parts of the program. DOT has the lead responsibility for coordinating civil requirements from all civil departments and agencies. The Department of State leads negotiations with foreign governments and international organizations on GPS PNT matters and regarding the planning, operations, management, and use of GPS.

We have not assessed the effectiveness of the GPS executive committee and past reports have still highlighted coordination problems. For instance, in 2010, we identified challenges in setting requirements for GPS satellites as the DOD process was daunting and confusing to civil government agencies.[1] In 2013, we reported on challenges in coordinating the development of back up capabilities for GPS.[2] Nevertheless, having an executive committee structure for weather similar to the one for PNT could help to more clearly define roles and responsibilities and provide a mechanism that requires departments and agencies to come together as they plan for future capabilities and resolve challenges, such as potential gaps in coverage. Coordination problems with weather satellites have been an issue for too long not to consider mechanisms such as a National Executive Committee.

[1] GAO, *Global Positioning System: Challenges in Sustaining and Upgrading Capabilities Persist*, GAO-10-636 (Washington, D.C.: September 15, 2010).

[2] GAO, *GPS Disruptions: Efforts to Assess Risks to Critical Infrastructure and Coordinate Agency Actions Should Be Enhanced*, GAO-14-15 (Washington, D.C.: November 6, 2013).