NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

Audit of the Joint Polar Satellite System: Continuing Progress in Establishing Capabilities, Schedules, and Costs Is Needed to Mitigate Data Gaps

FINAL REPORT NO. OIG-12-038-A
SEPTEMBER 27, 2012

U.S. Department of Commerce
Office of Inspector General
Office of Audit and Evaluation

For Public Release

UNITED STATES DEPARTMENT OF COMMERCE
Office of Inspector General
Washington, D.C. 20230

September 27, 2012

MEMORANDUM FOR: Dr. Jane Lubchenco
Under Secretary of Commerce for Oceans and Atmosphere

FROM: Allen Crawley
Assistant Inspector General for Systems Acquisition
and IT Security

SUBJECT: *Audit of Joint Polar Satellite System: Continuing Progress in Establishing Capabilities, Schedules, and Costs Is Needed to Mitigate Data Gaps*
Final Report No. OIG-12-038-A

Attached is our final audit report on the continuing development of the Joint Polar Satellite System (JPSS). This audit continued our oversight of JPSS since its inception. Our objectives were to (1) assess the adequacy of JPSS formulation activities—including the development of requirements (capabilities), schedule, and cost baselines—and (2) monitor the program's efforts to maintain continuity of polar satellite data.

To accomplish our objectives, we interviewed NOAA and NASA managers and staff within the program, the NOAA Office of the Chief Financial Officer, the Center for Satellite Applications and Research, and the National Centers for Environmental Prediction. We reviewed program and budget documentation and attended multiple JPSS program management reviews.

We concluded that while progress has been made, the program's capabilities, schedule, and cost baselines remain uncertain. NOAA has not articulated an acquisition strategy for the JPSS-2 spacecraft, and JPSS-3 and JPSS-4 satellites (including instruments), for which contractual and technical decisions must be made in the coming year. The program is revising ground system requirements, which may result in more efficient processing of environmental data records. Delay in formally establishing the program's governance structure and inadequate staffing may have prolonged program formulation activities. And NOAA should assess proposed legislation's potential impact to program capabilities, schedule, and cost.

NOAA does not have a policy that ensures consistent and reliable cost estimating for its major system acquisitions. When examining NOAA's process for estimating JPSS life-cycle costs, we found that a clearly defined program and a more mature cost-estimating process are needed. The program's revised cost estimate, derived to meet a life-cycle cost cap and artificially flattened funding profile, is not consistent with typical space acquisitions. An independent cost estimate is needed to assess whether the program is executable under these constraints.

For our second objective, we concluded that ground system work and other efforts to operationalize Suomi NPP data have had mixed results thus far. Despite technical anomalies, the program sufficiently validated a key data record so that it could be used for operational weather forecasting within 7 months of Suomi NPP's launch, although other data records cannot be used operationally until December 2013. An ongoing dispute over the management

of calibration and validation of data records requires further attention. Finally, we have refined our assessment of the expected data gap between Suomi NPP and JPSS-1.

In responding to the draft audit report, NOAA concurred with all of our recommendations. We have summarized NOAA's response and made minor edits to the report, where appropriate, based on NOAA's suggestions. The final report will appear on OIG's website pursuant to section 8L of the Inspector General Act of 1978, as amended.

In accordance with Department Administrative Order 213-5, please provide us with your action plan within 60 days of the date of this memorandum. The plan should outline the actions you propose to take to address each audit finding and recommendation.

We would like to extend our thanks to NOAA for the courtesies shown our staff during our fieldwork. Please direct any inquiries regarding this report to me at (202) 482-1855 or Fred Meny, Director, Satellites and Weather Systems, at (202) 482-1931.

Attachment

cc: Dr. Kathryn D. Sullivan, Assistant Secretary for Environmental Observation and Prediction
Dr. David Titley, Deputy Under Secretary for Operations
Mary E. Kicza, Assistant Administrator for Satellite and Information Services
Geovette E. Washington, Deputy General Counsel, Department of Commerce
Mack Cato, Director, Office of Audit and Information Management

Report In Brief

SEPTEMBER 27, 2012

Background

NOAA, in partnership with NASA, is acquiring and developing the next generation of polar-orbiting satellites for its Joint Polar Satellite System (JPSS). JPSS components currently envisioned for the system comprise the Suomi National Polar-orbiting Partnership (Suomi NPP), JPSS-1, JPSS-2, and two free flyer satellites. NASA launched Suomi NPP on October 28, 2011. JPSS satellites will provide data for weather prediction and climate research. The free flyer satellites will also collect and locate environmental data, as well as detect and relay signals from emergency search and rescue beacons. Suomi NPP is a research and risk-reduction satellite; however, because of program delays in launching JPSS-1, NOAA must rely on Suomi NPP for key data used in weather forecasting. We are predicting a 10–16-month gap in weather forecasting data between the end of Suomi NPP's design life and the time when JPSS data will be operational.

Why We Did This Review

In our September 2011 report, *Challenges Must Be Met to Minimize Gaps in Polar Environmental Satellite Data,* we addressed the need for JPSS baseline capabilities, costs, and schedule to be finalized, because uncertain baselines translate to uncertain budget requirements. In this audit, we further examined the determination of program requirements and NOAA's process for estimating the program's life-cycle cost. Our objectives were to (1) assess the adequacy of JPSS formulation activities and (2) monitor the program's efforts to maintain continuity of polar satellite data.

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

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OIG-12-038-A

WHAT WE FOUND

NOAA must clearly define JPSS capabilities, schedule, and cost. By defining the program and refining its cost-estimating process, NOAA can ensure that the estimate for JPSS is reliable; the program's artificially flattened budget profile needs to be independently validated. Also, Suomi NPP data validation and ground system improvements are needed for operational use. Finally, a 10–16-month gap between Suomi NPP and JPSS-1 operational data is expected.

WHAT WE RECOMMEND

The Deputy Secretary for Operations should ensure that

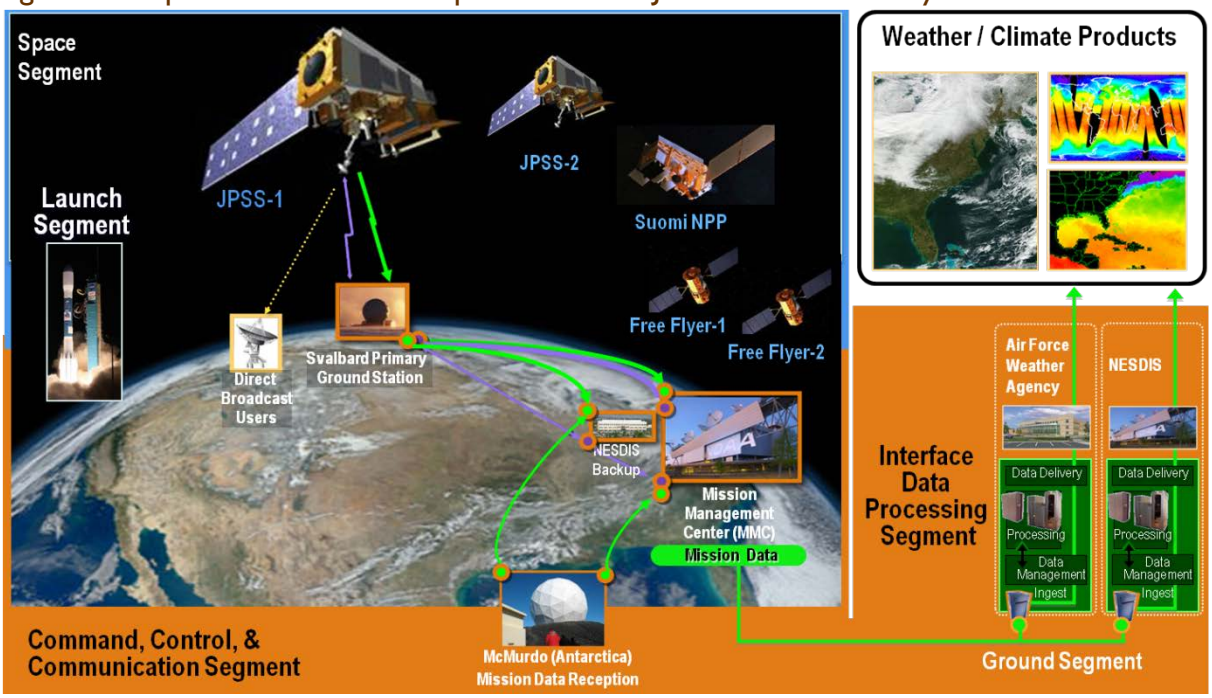
1. Sufficient resources and attention are given to finalizing JPSS high-level requirements and completing system definition.
2. The program's acquisition strategy for JPSS-3 and JPSS-4 is determined, documented, and shared with the Department, OMB, and Congress.
3. The National Environmental Satellite, Data, and Information Service (NESDIS) and the JPSS program quantify cost savings while determining how to efficiently process environmental data records.
4. NESDIS determines whether an enterprise approach to developing and maintaining data products from its environmental satellites could achieve economies of scale.
5. Sufficient resources and attention are given to permanently filling key management positions.
6. A policy that requires major system acquisition programs to adhere to cost-estimating best practices is developed.
7. Cost-estimating best practices are more closely adhered to in the JPSS program and other major system acquisitions.
8. An independent cost estimate adequately tests the viability of the program's funding profile.
9. Stakeholders are sufficiently informed of unplanned schedule and capability trade-offs, if needed, to meet surges in effort necessary for launches.

Contents

Introduction

NOAA, in partnership with NASA, is acquiring and developing the next generation of polar-orbiting operational environmental satellites for its Joint Polar Satellite System (JPSS). The satellites will cross the earth's equator in the early afternoon, an important time for sampling atmospheric conditions.[1] Formed in 2010 as a result of the restructuring of the National Polar-orbiting Operational Environmental Satellite System (NPOESS), the JPSS program comprises related projects that are intended to meet NOAA's mission needs and fulfill agreements with international partners. A Defense program intended to fulfill some NPOESS requirements, the Defense Weather Satellite System (DWSS), has since been canceled.

Figure 1. Simplified Schematic Composition of the Joint Polar Satellite System



Note: NESDIS is NOAA's National Environmental Satellite, Data, and Information Service.
Source: OIG adaptation of JPSS program schematic

Figure 1 is a simplified schematic of JPSS as currently envisioned. NOAA will command and control the satellites from its mission management center, with communications transmitted and data received via separate ground (antenna) stations. Once received on the ground, mission data travel via a network infrastructure to the ground system's data processing segment, which produces weather and climate products from the data. JPSS satellites (JPSS-1 and JPSS-2) will host instruments that provide environmental data used in weather prediction and climate research. The JPSS ground system, started under the NPOESS program, currently supports a

[1] The early afternoon polar orbit covers the peak of midday heating and thus provides critical data for modeling the physics of the atmosphere. Department of Defense and European satellites provide atmospheric data from the mid-morning. Defense satellites provide data from the early morning. Together, these satellites provide data for NOAA forecast models that are generally refreshed at 6-hour intervals over the entire globe.

risk-reduction satellite—Suomi National Polar-orbiting Partnership (discussed below)—by providing command, control, and communications and science data processing. The ground system will be upgraded to support the JPSS satellites. Data from satellites owned and operated by other agencies and international partners will also be processed and distributed. Additional plans call for "free flyer" satellites to host a climate sensor and instruments that collect and locate in situ environmental data, as well as detect and relay signals from emergency search and rescue beacons.

JPSS development follows NASA program management standards and practices.[2] The program is formally in the first major phase of the NASA program life cycle, *formulation*, the goal of which is to establish a cost-effective program that is demonstrably capable of meeting agency and mission goals and objectives. After successfully meeting formulation criteria, the program gains approval to proceed to the *implementation* phase, to execute the program and constituent projects while ensuring the program continues to contribute to agency goals and objectives within funding constraints. Practically speaking, however, JPSS is currently in both formulation and implementation phases, given that the program is a restructuring of NPOESS and its ground system is already built and operating the recently launched Suomi NPP satellite, and processing data. In addition, development of instruments for the first JPSS satellite, JPSS-1, is well under way.

In our September 2011 report, *Audit of the Joint Polar Satellite System: Challenges Must Be Met to Minimize Gaps in Polar Environmental Satellite Data*,[3] we addressed the need for JPSS baseline capabilities, costs, and schedule to be finalized, noting that uncertain baselines translated to uncertain budget requirements. This was particularly problematic given the fiscal environment and Congress's need for clear definitions of programs as it makes funding decisions. In this audit, we further examined the determination of program requirements and NOAA's process for estimating the program's life-cycle cost.

Our report also examined preparations for the launch of the NPOESS Preparatory Project satellite, now known as Suomi National Polar-orbiting Partnership (Suomi NPP),[4] a research and risk-reduction satellite intended to continue NASA's Earth Observing System (EOS) measurements and demonstrate the next generation of polar-orbiting operational environmental sensors (which will fly on JPSS satellites).[5] Due to NPOESS program delays and the aging of NOAA's current constellation of polar-orbiting operational environmental satellites (and NASA's EOS), however, NOAA must rely on Suomi NPP for key data used in operational weather forecasting. NASA successfully launched Suomi NPP on October 28, 2011. After commissioning the satellite and its instruments, NASA transferred operation of the satellite to

[2] NASA, March 2007. *Space Flight Program and Project Management Requirements,* NPR 7120.5D (including NASA Interim Directive 7120-97). Washington, D.C.: NASA.

[3] U.S. Department of Commerce Office of Inspector General, September 2011. *Audit of the Joint Polar Satellite System: Challenges Must Be Met to Minimize Gaps in Polar Environmental Satellite Data*, OIG-11-034-A. Washington, D.C.: Department of Commerce OIG.

[4] On January 25, 2012, NASA renamed the satellite in honor of the late Verner E. Suomi, a pioneer in satellite meteorology.

[5] Research satellites demonstrate new technologies that, if successful, can be used in operational satellites. JPSS operational satellites are designed for a longer mission life and will be built to more robust engineering standards than Suomi NPP's research mission.

the JPSS program, which must complete calibration and validation[6] of Suomi NPP data records and add robustness to its ground system. The program is also incorporating lessons learned from Suomi NPP's development as it develops its operational-grade satellites, JPSS-1 and JPSS-2, which will host nearly the same suite of instruments as Suomi NPP and are currently slated for launches in 2017 and 2022, respectively.

This audit continued our oversight of JPSS since its inception.[7] Our objectives were to (1) assess the adequacy of JPSS formulation activities, including the development of requirements (capabilities), schedule, and cost baselines, and (2) monitor the program's efforts to maintain continuity of polar satellite data.

We concluded that while progress has been made, the program's capabilities, schedule, and cost baselines remain uncertain. NOAA has not articulated an acquisition strategy for the JPSS-2 spacecraft, and JPSS-3 and JPSS-4 satellites (including instruments), for which contractual and technical decisions must be made in the coming year. The program is revising ground system requirements and this may result in more efficient processing of environmental data records. Delay in formally establishing the program's governance structure and inadequate staffing may have prolonged program formulation activities. And NOAA should assess proposed legislation's potential impact to program capabilities, schedule, and cost.

NOAA does not have a policy that ensures consistent and reliable cost estimating for its major system acquisitions. When examining NOAA's process for estimating JPSS life-cycle costs, we found that a clearly defined program and a more mature cost-estimating process are needed. The program's revised cost estimate, derived to meet a life-cycle cost cap and artificially flattened funding profile, is not consistent with typical space acquisitions. An independent cost estimate is needed to assess whether the program is executable under these constraints.

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[6] Calibration is the quantification of a sensor's performance in relation to a traceable standard. Validation is the assessment of data product quality using independent data sources of known quality.

[7] See also our interim report of the September 2011 audit: Memorandum to the Under Secretary for Oceans and Atmosphere, June 10, 2011 (OIG-11-029-M).

Findings and Recommendations

I. NOAA Must Clearly Define JPSS Capabilities, Schedule, and Cost

In September 2011, after a lengthy process,[8] NOAA's Deputy Under Secretary for Operations formally approved preliminary high-level requirements for JPSS (its full-scope program) and a cost estimate was subsequently validated. However, during a February 2012 submission to the President's Budget for Fiscal Year 2013, the Department and NOAA informed Congress of potential changes to those requirements—including removing environmental sensors and reducing the timeliness of satellite data—in order to reduce the program's life-cycle cost. NOAA officials told us that during the budget formulation process the decision was made, with both the Department and Office of Management and Budget (OMB), to cap the program's life-cycle cost at $12.9 billion and even out the program's year-over-year funding profile, to bring stability to JPSS budget requests.

The proposed $12.9 billion life-cycle cost cap was not derived from a rigorous cost estimate at the time it was submitted for the FY 2013 President's Budget. Rather, the program had spent much of 2011 developing a cost estimate for its full-scope program, totaling $14.7 billion. An independent cost estimate, using somewhat different assumptions, concluded that program costs would total $16.1 billion. NOAA subsequently revised its cost estimate to determine the optimal capabilities and schedule that could be delivered under the $12.9 billion cap.

The JPSS program completed its system requirements review, to evaluate whether its requirements were properly formulated and the program's estimated cost and schedule were credible, in late May 2012. As part of the review, the program presented the $12.9 billion revised estimate to the program's standing review board,[9] along with its determination of the optimal capabilities and schedule that it could deliver under the cost cap. (According to the program, the estimate supports most of the capabilities NOAA intended for the program, although data latency—the time period from satellite observation until data is delivered to users—will not be as short as initially planned and there was an additional 3-month delay in the scheduled launch date of JPSS-1.) A successfully completed system requirements review was a prerequisite to Key Decision Point 0 (July 20, 2012), from which the Under Secretary for Oceans and Atmosphere determined that the program should proceed with system definition activities. After a system definition review, the program reaches Key Decision Point 1 (scheduled for July 2013), when it is expected to have completed formulation activities and developed an acceptable plan (projects are feasible and risks acceptable) for implementation. From this point, the program commits to being measured against its approved capabilities, schedule, and cost baselines.

[8] See OIG-11-034-A for a discussion of requirements delay under finding II, part C: "JPSS Program's Baseline Capabilities, Costs, and Schedule Need to Be Finalized."

[9] The standing review board is responsible for conducting independent reviews (life cycle and special) of a program/project and providing objective, expert judgments to the convening authorities.

A. JPSS requirements have been unstable since the restructure of NPOESS, changing the basis of program cost estimates

While unstable requirements can be typical of programs in the formulation phase, in prior reporting we have noted that decisions on capabilities, schedule, and costs were needed.[10] NOAA's burden of what were previously NPOESS requirements has increased due to the cancellation of DWSS. Also, according to program staff, some of the NPOESS requirements have become outdated, and a reassessment of those requirements in light of current needs—as well as fiscal constraints—is necessary. The JPSS program will not formally commit to a program baseline until after Key Decision Point 1, currently planned for July 2013, nearly 3.5 years after the White House decision to restructure NPOESS.

Before and after leadership approved the program's preliminary high-level requirements in September 2011, funding and other considerations repeatedly spurred NOAA to adjust what the JPSS program would actually provide to its users. These changes in capabilities have had ramifications for the life-cycle cost estimates reported by the program.

Table 1: JPSS Cost Estimates and Major Assumptions

	2009 Initial Estimate (for FY 2011 PB[a])	2011 Estimate[b]	2012 Estimate (for FY 2013 PB)
Cost (in billions)	$11.9	$14.7–$16.1	$12.9
Life cycle (from FY2009 and prior)	2024	2028	2028
Satellites	Suomi NPP,[c] JPSS-1, JPSS-2	Suomi NPP,[c] JPSS-1, JPSS-2 , and five free flyers	Suomi NPP,[c] JPSS-1, JPSS-2, and two free flyers
JPSS satellite launch readiness dates	JPSS-1: FY 2015 JPSS-2: FY 2018	JPSS-1: Q1[d] FY 2017 JPSS-2: Q2 FY 2021[f]	JPSS-1: Q2[e] FY 2017 JPSS-2: Q1 FY2022[e]

[a]President's Budget. [b]Cost figures for 2011 represent the program office and independent cost estimates, respectively. [c]JPSS costs include some development and all operational costs for Suomi NPP. [d]First quarter. [e]Second quarter. [f]While JPSS-2 is planned to be launch-ready by Q1 FY 2022, its actual launch date is to be determined.
Source: OIG analysis of data from JPSS program.

As an example, NOAA's initial cost estimate, submitted for the FY 2011 President's Budget, was $11.9 billion. NOAA indicated that this estimate had an eighty percent confidence level (an assessment of risk and uncertainty), which an independent review team had recommended for its predecessor program to be adequately funded. This initial cost estimate included five Visible/Infrared Imager Radiometer Suite (VIIRS) sensors, no

[10] Commerce OIG, *Audit of the Joint Polar Satellite System* and interim report. See also U.S. Government Accounting Office, May 2010. *Polar-Orbiting Environmental Satellites: Agencies Must Act Quickly to Address Risks That Jeopardize the Continuity of Weather and Climate Data,* GAO-10-558. Washington, D.C.: GAO.

accommodation for a key climate sensor and other instruments,[11] and a life cycle through FY 2024. Subsequent cost estimates have included three VIIRS sensors (for Suomi NPP, JPSS-1, and JPSS-2), and the life cycle has been extended 4 years to FY 2028. The program has added requirements to launch a climate and other sensors on smaller, free flyer satellites. In addition, climate sensors originally funded outside of the program (although within NOAA's overall budget) have been added to the JPSS budget. Table 1 contains the history of JPSS cost estimates developed thus far and their major assumptions of program content and schedules.

NOAA is currently reviewing and prioritizing requirements to complete program formulation; final decisions on changes to requirements are targeted for November 2012. In the absence of finalized requirements, NOAA has been providing NASA direction letters for anticipated system requirements and design decisions. Still, NASA has reported that late development of the requirements baseline is an issue that could impact launch readiness dates for both JPSS-1 and the free flyer satellites.

B. Changing requirements and acquisition strategies increase cost and schedule risk and challenge program management

The JPSS program has reported the changing requirements baseline as a program risk that could delay the readiness of the JPSS ground system and the JPSS-1 launch date. NASA's JPSS acquisition program also has warned of launch delays for both JPSS-1 and the free flyers and has indicated difficulty with making informed decisions. Before the FY 2013 President's Budget and the program's system requirements review had been completed, contracts were not reflective of the program's planned capabilities, schedule, and funding profiles. A lack of technical (capabilities), schedule, and cost baselines leaves managers without adequate means to assess contractor and overall program performance.

Ground system requirements. Although JPSS completed its program-level system requirements review in May, a project-level review of its ground segment requirements, originally scheduled in advance of the program-level review, was delayed until late August. The program has been studying options for revising its ground system architecture, which was originally conceived under NPOESS and, because of custom interfaces and tightly coupled hardware and software,[12] makes interoperability and interfacing with partner institutions more difficult. The program's goal is to move toward a more open, adaptable, standardized architecture that will allow the program to save costs by interfacing with international and other partners for mission data. One such example of this approach, already under way, is the program's efforts to use data from a Japanese satellite, GCOM-W,[13] which launched May 18, 2012. In addition, requirements for the ground system's support for Defense partners have changed as a result of Defense's own fiscal constraints and the cancellation of DWSS.

[11] The Total Solar Irradiance Sensor (TSIS) will measure the variability in the sun's total output. It will continue measurements of NASA's Solar Radiation and Climate Experiment research mission. The other instruments are Search and Rescue Satellite-Aided Tracking (SARSAT), and Argos Data Collection System (ADCS).
[12] Tightly coupled hardware and software components are linked together and dependent on each other.
[13] Global Change Observation Mission 1st–Water.

Free flyer requirements. Further, design decisions for the free flyer project are pending. Program staff members are deciding how best to meet the requirements for the different instruments for which the free flyer project is responsible.[14] One such decision pertains to the ground system(s) that the instruments will require to meet their security needs. The free flyers are currently budgeted to have a ground system provided by an institutional partner. But higher security requirements could instead require services from the JPSS ground segment, likely at greater cost.

Acquisition strategy for JPSS-2. The program plans to decide whether to competitively award a contract for the JPSS-2 spacecraft by December, according to status reports. (The program has chosen to sole-source contracts for JPSS-2 instruments.)

Acquisition strategy beyond JPSS-2. Finally, life-cycle cost and documented program plans are limited to JPSS-1 and JPSS-2. Although decisions need to be made soon to support the procurement and development of JPSS-3 and JPSS-4, NOAA has not included either satellite in its FY 2012 or FY 2013 budget justification. NOAA should ensure that stakeholders are aware of any impact that the development and acquisition of these satellites will have on the JPSS program.

C. Requirement changes may also result in more efficient processing and distribution of data

NOAA's JPSS program is looking for ways to more efficiently deliver its required capabilities. As currently defined, JPSS high-level requirements call for the ground system to convert *raw data records* (RDRs) first into *sensor data records* (SDRs) and then into *environmental data records* (EDRs), by applying algorithms (in the form of software code).

The additional processing for EDRs (outlined in bold in figure 2) may be more efficiently performed in a downstream NOAA system, separate from JPSS, known as NPOESS Data Exploitation (NDE–dashed outline in figure). Because of legacy NPOESS specifications and design decisions, the JPSS data processing segment, built for Suomi NPP, does not produce EDRs in a format compatible with National Weather Service (NWS) systems. The NDE system reformats JPSS data records for NOAA users. NDE also creates NOAA-unique products from the data, in some cases combining data from other sources. In addition, NDE separately produces some EDRs from JPSS sensor data. JPSS program leaders are examining whether NDE can process EDRs more efficiently and therefore provide an opportunity to reduce the complexity and cost of the JPSS ground system.

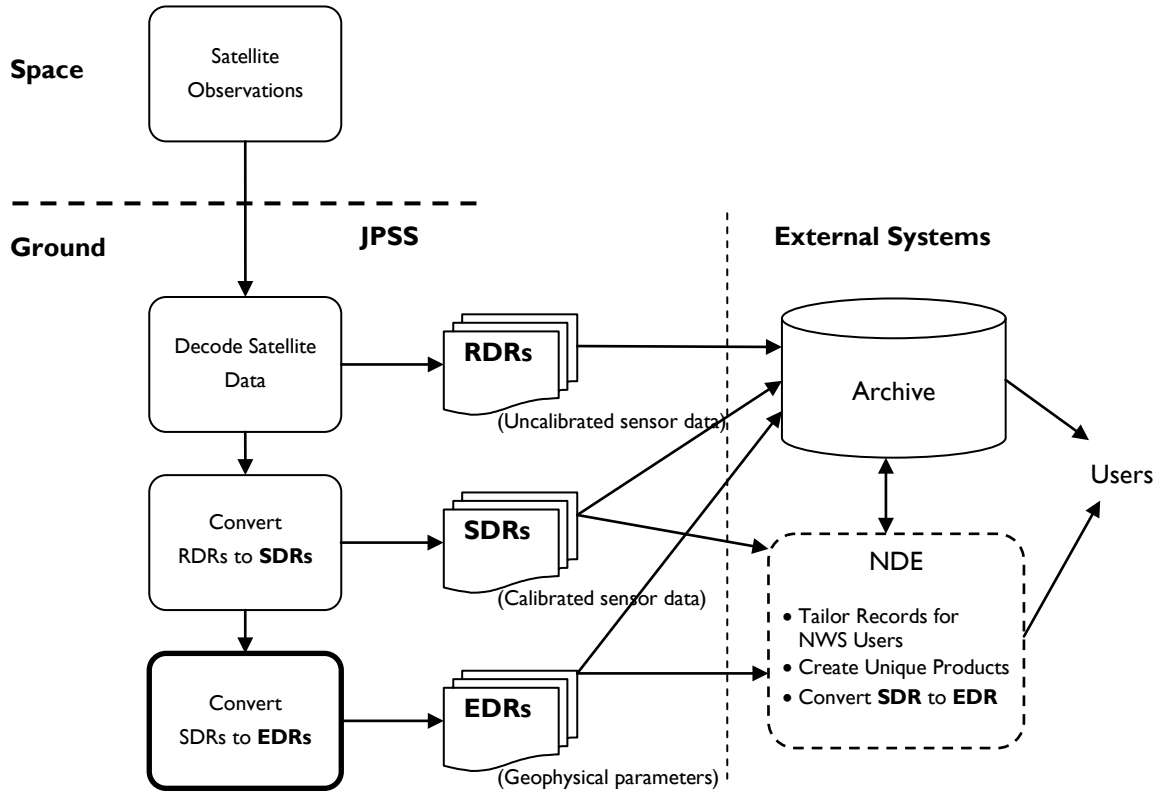
Unfortunately, program leadership has not yet been able to quantify the potential cost savings. It is expected that the program would fund the NDE program for the additional processing, although it does not fund NDE for current processing. We believe more could be done to determine cost savings.

Additionally, we believe NOAA should determine whether an enterprise approach to developing and maintaining data products from its environmental satellites could achieve

[14] The three instruments planned for free flyers are the Total Solar Irradiance Sensor (TSIS), Search and Rescue Satellite-Aided Tracking (SARSAT), and Argos Data Collection System (ADCS).

economies of scale and complement other efforts to modernize National Environmental Satellite, Data, and Information Service (NESDIS) system architecture. Users would likely benefit from data product standardization and new products.

Figure 2. Processing Flow of JPSS Satellite Data Records



Source: OIG adapted from program documentation.

D. Delayed governance structure, planning, and staffing may have prolonged program formulation

NOAA and NASA leadership approved the JPSS Management Control Plan—which documents their agreement on the roles and responsibilities, the governance structure, and program authorities for JPSS—in early February 2012, or 2 years into the life of the program. Preliminary NOAA and NASA program plans were produced in time for the program's May 2012 system requirements review. At that review, the program's standing review board commented on what seemed a complex governance structure but ultimately concluded that it was working.

The program has had key staff in acting, rather than permanent, capacities for extended periods of time. A permanent NOAA JPSS director began work in September 2011. NOAA's Deputy Under Secretary for Operations—who is deemed the final authority for the program's high-level requirements, schedule, and budget submissions—retired in January 2012 and was not permanently replaced until July. This interim period included the FY 2013 President's Budget submission and other decisions on high-level requirements. In

June 2012, the acting NESDIS Deputy Assistant Administrator for Systems, serving on a detail from NASA since May 2011, left NOAA to return to NASA. Now vacant, this position serves as the single NOAA source of strategic direction and programmatic guidance to NASA, according to the agencies' management control plan for the program. Several other key positions within NESDIS and the program are filled by detailed employees in acting rather than permanent capacities. NOAA has attributed the delays in establishing JPSS' governance and permanently staffing key positions, in part, to funding shortages in FYs 2010 and 2011.

E. Proposed legislation that would restructure the program requires an assessment of capabilities, schedule, and cost impacts

The Senate Appropriations Committee bill for FY 2013[15] includes a provision that would transfer funding and responsibility for procurement of NOAA's operational satellites to NASA, instituting a new management structure for JPSS. However, OMB has not yet issued an official Statement of Administration Policy to Congress on the matter. NOAA will need to complete an assessment of its potential impact to the program's capabilities, schedule, and cost, should this provision become law.

II. A Clearly Defined Program and a More Mature Process Are Needed to Ensure a Reliable JPSS Cost Estimate

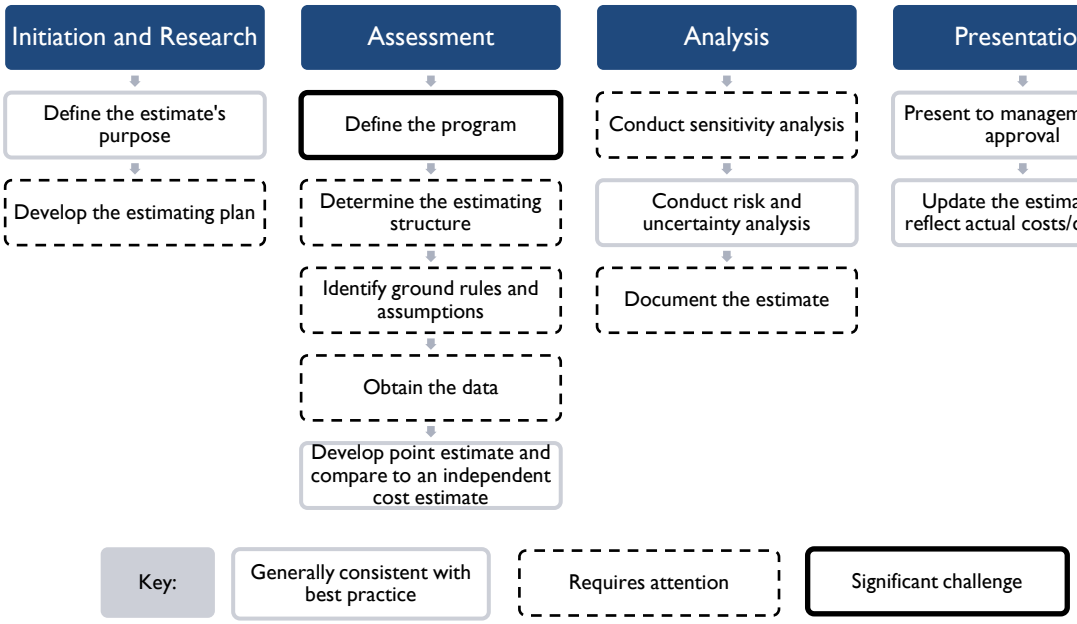
NOAA does not have a policy to effect consistent and reliable cost estimates for its major system acquisition programs. NOAA officials told us that in 2011 the agency followed the same practices developing the JPSS cost estimate that it had used for the Geostationary Operational Environmental Satellite-R Series program (another major system acquisition), although the officials had not documented and could not clearly articulate the overall methodology. We conducted a best practice[16] assessment of NOAA's activities undertaken in 2011 to develop a JPSS life-cycle cost estimate. During our fieldwork, in early 2012, the program was in the process of revising its estimate to conform to the $12.9 billion life-cycle cost cap. Because that activity was ongoing and involved pre-decisional information, we did not review it as part of this audit. However, our findings related to the program's 2011 cost-estimating activities should provide guidance for improving the reliability of the JPSS life-cycle cost estimate as it is updated for Key Decision Point I.

Figure 3 depicts the steps in a best practice cost-estimating process and our evaluation of NOAA's process for JPSS, with the most significant challenge outlined in bold and other areas that require attention indicated with dashed outlines.

[15] Commerce, Justice, Science, and Related Agencies Appropriations Act, 2013, S. 2323, 112th Cong. (2012); *see also* Senate Report 112-158 (discussing Committee rationale for transfer to NASA).

[16] U.S. Government Accountability Office, March 2009. *GAO Cost Estimating and Assessment Guide: Best Practices for Developing and Managing Capital Program Costs,* GAO-09-3SP. Washington, D.C.: GAO.

Figure 3. Evaluation of NOAA's Cost Estimating Process for JPSS



Source: OIG analysis of NOAA cost-estimating activities against GAO-defined best practices.

A. *Clearly defining the program is the most significant challenge to developing a reliable life-cycle cost estimate for JPSS*

Define the program. As described in finding I, the program content and scope of the estimates NOAA has reported have varied greatly. While defining the program is one goal of the formulation phase of a program life cycle, some JPSS component projects are actually at more mature phases than the overall program. All of the instruments for JPSS-1, for example, are more than 60 percent built, and nearly all NPOESS contracts have been transitioned to NASA and definitized, indicating agreement on the work to be performed and the cost. This provides cost analysts with data from which to construct elements of the estimate. But due to the potential for requirements or system design changes (particularly for the ground and free flyer segments), uncertainty in some of those costs remains.

Clear requirements are needed to adequately define the program in a Cost Analysis Requirements Description (CARD). This document serves as the technical baseline of the program and can include the acquisition strategy, technical definition, characteristics, system design features, and technologies. The more completely defined a program is, the fewer assumptions cost analysts must make, leading to a more reliable cost estimate. In 2011, the JPSS CARD was constructed in what program officials described as a compressed time frame, beginning in March and concluding in June. As we reported in September 2011, the CARD was completed without an approved set of high-level requirements.

B. Aspects of JPSS cost estimating require attention as the program formally baselines costs

The following aspects of cost estimating require management attention to ensure the program has a reliable cost estimate in time for its next programmatic milestone: Key Decision Point 1, in July 2013.

Develop the estimating plan. The JPSS program office estimate developed in 2011 was done without a written cost-estimating plan. Both program officials and the cost-estimating contractor described an ad hoc approach in which certain activities were rushed and documentation was lacking. Instead of providing specific cost-estimating activities and a schedule, a draft copy of an estimating plan completed in February 2012 comprised a general list of methodologies, standards, and guidelines.

Determine the estimating structure. One such standard—also a best practice—requires the use of a product-oriented work breakdown structure in estimating the cost of program elements.[17] Establishing a product-oriented cost structure allows a program to track cost and schedule by defining deliverables, such as hardware or software components. The program can then more effectively identify elements that are causing a cost or schedule variance and thereby more efficiently mitigate the cause of the variance. While the program provided dictionaries of both product-oriented and functional work breakdown structures, its cost estimate was aligned with the functional structure.

Further, the JPSS cost estimate structure was not sufficiently detailed and did not always match the defined functional work breakdown structure. Best practice and the program's standard call for at least three levels of cost elements and four to five levels for certain high-risk cost elements. Yet, the program office estimate included just one line item, based on contract values, for JPSS sensors, whose development accounted for significant cost overruns under NPOESS. The estimate did not break out costs for design, development, fabrication, assembly and test of the instruments. Neither did the estimate conform to the program's defined functional work breakdown structure, which includes two elements for its instrument costs: one for each instrument contract and a second element for management and support related to each instrument. The program office estimate, however, did not include the instrument-specific management and support cost element. Instead, those costs were aggregated under "labor" elements for all instruments. As such, the 2011 estimate obscured costs of some of the program's defined functional cost elements.

Identify ground rules and assumptions. The basis of estimates should be clearly documented. In general, we found that a clear accounting of all ground rules, assumptions, and drivers forming the basis of JPSS estimates was lacking. While a set of ground rules and assumptions was documented in the program's CARD, the actual ground rules and assumptions that formed the basis of the program office and independent cost estimates differed. For example, the CARD projected a life cycle to FY 2024, while the program office and independent cost estimates projected a life cycle to FY 2028. And while both the CARD

[17] U.S. Department of Defense, October 2011. *Work Breakdown Structures for Defense Materiel Items,* MIL STD-881C. Arlington, VA: DoD.

and the independent cost estimate assumed that contracts for JPSS-2 instruments and spacecraft would be competitively awarded, the assumption for the program office estimate was that instrument contracts would be sole-sourced. This difference was recognized in the reconciliation of the two estimates, but generally the basis of these estimates should be the same, to provide a more valid comparison.

Further, NASA's cost estimate for its acquisition program, which was the source of much of the program office estimate's data, was based on significantly different assumptions about the scope of the program, including the number of JPSS satellites. NASA assumed four instead of two (i.e., JPSS-1, JPSS-2, JPSS-3, and JPSS-4). This was presumably because NASA's estimate was initiated before the JPSS CARD was complete but may also indicate miscommunication between the agencies.[18] As a result of the different assumptions, NOAA's cost analysts had to adjust certain cost elements and remove costs for the two additional satellites assumed by NASA. Still, at least one cost element in NOAA's estimate, for program management, was not detailed with the lower level cost elements, obscuring the adjustments made by the cost analysts.

Obtain the data. In some cases, the NOAA and independent cost analysts had difficulty collecting quality historical and other data that could be used for developing the estimates. The independent cost-estimating team was critical of the CARD's lack of technical details for the ground system and told us that it struggled to obtain more specifics from the program and its ground system contractor. JPSS' life-cycle cost includes sunk costs[19] from work completed under the NPOESS program in FY 2010 and prior; NOAA had not completed an accounting effort of the sunk costs before it finished the program office estimate. NOAA's cost analysts did not have underlying details from NASA's cost estimate that served as major input to the program office estimate. Further, the cost analysts told us that they were not included in NASA meetings and learned of design changes from monthly program status review materials. This was echoed by a NASA program official, who separately told us that NOAA's cost analysts did not attend NASA's technical meetings and likely did not have adequate knowledge of design decisions.

Conduct sensitivity analysis. A sensitivity analysis consists of identifying key cost drivers and varying individual parameters to determine which are most sensitive to change. The results should include a range of possible costs and a method for performing "what-if" analysis for system design decisions. As such, sensitivity analysis is valuable for making informed decisions as to the best options for delivering planned capabilities. Sensitivity analyses should be well-documented and presented to management for decisions. Yet, the JPSS program office estimate developed in 2011 did not include documentation of this best practice.

Document the estimate. A reliable cost estimate is comprehensive and accurate and can be easily and clearly traced, replicated, and updated. It should include data sources, the process

[18] In fact, NASA is currently reporting that major contractual and technical decisions pertaining to JPSS-2, JPSS-3, and JPSS-4 must be made in 2012 to support procurement activities starting in 2013. Thus far, the Department and NOAA are constraining the scope of JPSS cost estimates to just the first two satellites.
[19] Sunk costs are costs that have already been incurred and cannot be recovered.

followed, and methods used. Aside from the CARD and a management brief, the JPSS program office estimate was supported by limited documentation. The estimate itself consisted of a single electronic spreadsheet. Comment fields in the spreadsheet sometimes referred to the data source for a given cost element, which in nearly all cases was a NASA brief of its own cost estimate for the program. As a whole, documentation for the program office estimate did not adequately identify or include data sources, assumptions, methods, and decisions basic to the estimate. When we discussed it with them, NOAA's cost analysts acknowledged that the estimate was not documented to an extent consistent with best practice.

III. NOAA Should Address Concerns with Revised Cost Estimate

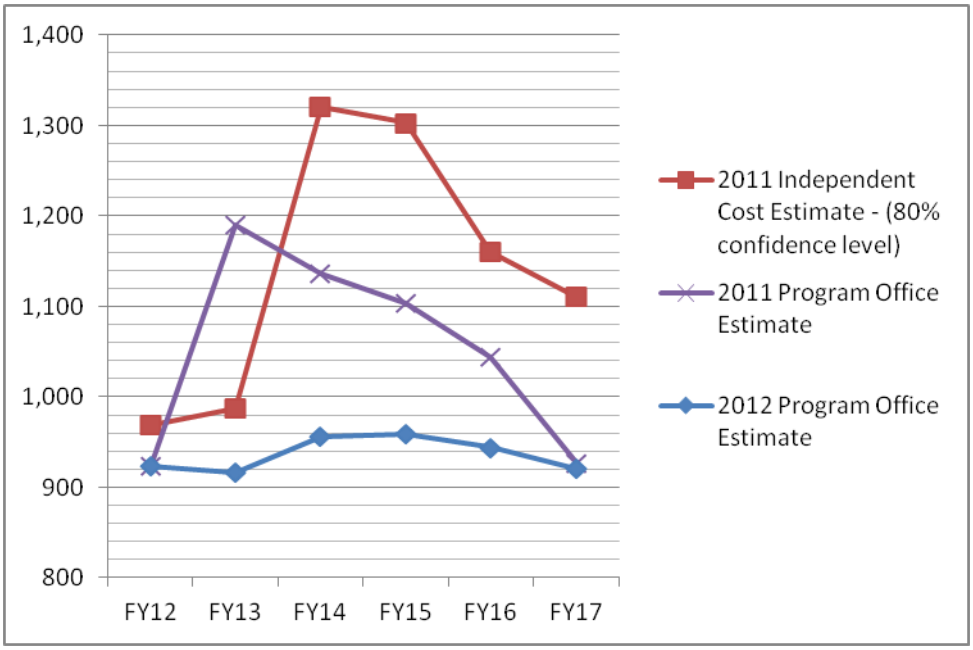
The revised program office estimate, supporting a $12.9 billion life-cycle cost, was briefed to OMB in early June. The revised estimate indicated that, contrary to proposals made in the FY 2013 President's Budget submission, much of the original program content included in its preliminary high-level requirements document could be retained under the cost cap. While the revised estimate was not available for review during our fieldwork, NOAA's JPSS Director and Deputy Director gave us an overview of the estimate (with the same presentation used to brief OMB) in early August. In advance of Key Decision Point 1, the program should address the following concerns about its reliability:

- Despite OMB's approval of the program's revised capabilities and schedule, there remains a high degree of uncertainty in design requirements of the free flyer project, which has the potential to cost significantly more than what is currently budgeted (see our discussion of free flyer requirements in finding I). The program is also formulating significant design changes for the ground system. And the program is currently revising the CARD, which provides the technical baseline needed to properly derive an estimate.

- An independent cost estimate has not validated the revised estimate.

- Intended to bring stability to the appropriation, the revised estimate includes an artificially flattened budget profile for FY 2013–FY 2017 at $900 million per year, plus the cost of climate sensors previously budgeted in a different NOAA program. As depicted in figure 4 and acknowledged by program managers, however, space acquisitions typically exhibit peaked funding profiles. In the figure, the 2011 program office and independent cost estimate curves demonstrate the surge in resources necessary to ensure completion of development, integration, and testing of sensors, spacecraft, and launch vehicles; this is much less evident in the revised estimate for the FY 2013 President's Budget.

Figure 4. Budget Profiles (FY 2012–FY 2017) of JPSS Cost Estimates (in millions of FY 2010 dollars)



Source: OIG presentation of program data

An artificially flattened profile restricts access to needed resources, without which the program's ability to deliver promised capabilities and meet schedules is at risk. As such, there is an increased likelihood that the program will need to delay the delivery of capabilities postlaunch in order to sufficiently fund the most critical work preparing for launch. We have concerns as to whether stakeholders (in particular, users of JPSS data) will be adequately informed and prepared for such decisions, should they occur (see, for example, finding IV, part B, below).

IV. Suomi NPP Data Validation and Ground System Improvements Needed for Operational Use

As we reported in September 2011, some of Suomi NPP's key instruments encountered technical issues as they were built, and they were launched with significant residual risks. Since the October 28, 2011, launch, there have been on-orbit anomalies with Suomi NPP's sensors, including one that prolonged the satellite's checkout phase by 6 weeks. Issues with certain data records and additional constraints from a planned upgrade of supercomputers used in numerical weather prediction[20] will delay the operational use of those data records until December 2013.

[20] Numerical weather prediction models use millions of weather data (for example, temperature, pressure, wind) to represent current conditions and make predictions of future states of the atmosphere.

The JPSS program was able to sufficiently validate important sensor data records from the Advanced Technology Microwave Sounder (ATMS), which provides temperature and moisture data that significantly contribute to numerical weather prediction. As of May 22, 2012, or 7 months after Suomi NPP's launch, ATMS data records were being assimilated into NOAA's global forecast system, which is the foundation for all medium-range (3–7 day) forecasts in the United States.

In March 2012, NASA's NPP program formally accepted the Suomi NPP satellite from its contractor, Ball Aerospace. Then, after a successful operations transfer review, the JPSS program accepted responsibility for interim Suomi NPP satellite operations. Approximately 15 months postlaunch, Suomi NPP satellite operations will be turned over to NOAA's Office of Satellite and Product Operations. While many of the difficulties the program has faced are typical for a new satellite system, continued follow-through on actions in response to our prior recommendations is needed.

A. Degradation of Visible/Infrared Imager Radiometer Suite sensor delayed Suomi NPP commissioning

Approximately 1 month after Suomi NPP's launch, NASA's project team discovered that VIIRS's sensitivity in certain spectral bands[21] was degrading. As an investigation was launched, measures were taken to isolate VIIRS and prevent other Suomi NPP instruments from being damaged, essentially halting planned commissioning activities. The investigation ultimately delayed Suomi NPP commissioning 6 weeks and, in particular, use of the Cross-track Infrared Sounder (CrIS).

The root cause was determined to be tungsten oxide contamination on VIIRS' mirrors stemming from a deviation in the manufacturing process. The degradation correlated with solar exposure and affected a limited number of spectral bands detected by VIIRS. While continuing, the rate of degradation is predicted to level off, and the quality of the sensor's data is currently expected to exceed specifications even after 7 years of operation.

Suomi NPP's VIIRS was built under the NPOESS program, which, as we discussed in our September 2011 report, was managed by a contractor with limited government oversight. Nevertheless, it is concerning that a sensor with optics such as VIIRS' was not subjected to testing sufficient to have identified the contamination. NASA has taken steps to ensure such testing will be done on the next VIIRS sensors (to fly on JPSS-1 and JPSS-2), better simulating space environment exposures that are most significant to a very important sensor.

[21] Finite segments of wavelengths in the electromagnetic spectrum.

B. Deferred ground system work, sensor data record discrepancies, and a planned modernization of NCEP's supercomputer system will result in unforeseen delay in operational use of Suomi NPP data

The Cross-track Infrared Sounder (CrIS) will provide key data—atmospheric temperature, moisture, and pressure—that complement ATMS data and will be used in numerical weather prediction. As a result of the VIIRS degradation described above, however, the flow of CrIS data from the satellite to the ground system was delayed approximately 6 weeks until mid-January 2012. Additional ground system updates delayed full analysis of CrIS sensor data records another week or more. At this point, the program discovered errors in the data records that required additional ground system software changes.

Some of the errors with CrIS data records were the result of ground system work deferred until after Suomi NPP's launch, which we cautioned in our September 2011 report could delay operational use of data. An error discovered after initial CrIS data were reviewed—incorrect geo-location codes[22]—prevented the data from being tested by the National Centers for Environmental Prediction (NCEP) for use in its numerical weather prediction models. Therefore, CrIS data could not be assimilated into NCEP's operational forecast system during its system changes in May 2012. Further, due to planned upgrades to NCEP's supercomputers in 2012–2013 and a subsequent system freeze during the 2013 hurricane season, CrIS data cannot be assimilated for operational forecasting until the next available window in December 2013. These same factors apply to other Suomi NPP data records (from VIIRS and the Ozone Mapping and Profiler Suite [OMPS]) that will be used for operational weather forecasting.

NCEP officials told us there also may have been some misunderstanding with the JPSS program regarding NCEP's need for CrIS data as soon as possible. According to the JPSS ground segment project manager, the programmatic interface with NCEP was through NOAA's NPOESS Data Exploitation System, which further processes ground system data for NOAA users. While the circumstances described above were likely unavoidable, together they illustrate a need expressed in a recommendation in the September 2011 report: NOAA's Deputy Under Secretary for Operations should coordinate efforts from across line offices to minimize the degradation of weather and climate forecasting.

C. Ground system risks realized early in life of Suomi NPP must be mitigated for operational use of data

As discussed in our September 2011 report, the ground system supporting Suomi NPP consisted of a single receiving station through which to downlink science data collected by the satellite's instruments. While the ground system's design may have been appropriate for Suomi NPP's conception as a research mission, we warned that without a secondary, geographically distinct receiving station, disruptions to ground equipment could result in loss or delay of data, which will soon be needed for operational forecasting.

[22] The latitude and longitude of environmental conditions observed by the sensor and from which the data were derived.

After Suomi NPP's launch, undersea cables connecting the receiving station in Svalbard, Norway, with the ground system's data processing components in the United States were cut or otherwise disrupted. Measures were taken to retain data at the receiving station, but data processing by the ground system was significantly delayed and would not have been useful for operational weather forecasting had it been needed. This spurred the program to stand up an emergency secondary receiving station in Fairbanks, Alaska, with spare equipment, repurposed for the emergency situation. The secondary downlink station does not provide full backup capability, and more work will be required to add sufficiently robust capability for operational needs.

Further, the program plans a stopgap measure for implementing a backup mission management center for Suomi NPP, also a recommendation in our September report. Longer term, the program plans to build a robust alternate ground system that will provide backup mission management and data processing capabilities in time to support JPSS-1.

D. Calibration and validation activities needed to operationalize data present management challenges

As reported in September 2011, the JPSS program has yet to reach agreement with NESDIS's Center for Satellite Applications and Research (STAR) on the management of science algorithms and calibration and validation activities needed to operationalize and maintain JPSS data products. While STAR scientists are leading program teams responsible for calibration and validation of data records, STAR staff report to their own management and support JPSS program staff, who manage the overall effort. STAR managers have stated they do not have sufficient authority to determine and manage their JPSS-related budget.

NOAA intended to finalize, by March 2012, a plan to transition management of these activities to STAR, which was in response to our recommendation. A final plan has not materialized, however, and both STAR and JPSS staff indicate that there is disagreement over the timeline for the transition. STAR staff proposed taking over management of calibration and validation activities once JPSS turns over operation of the Suomi NPP satellite to NOAA's Office of Satellite Products and Operations, planned for 15 months postlaunch (approximately February 2013). JPSS staff believe that the transition will be more appropriate once data records and underlying algorithms have reached a more stable phase sometime after launch of JPSS-1. In the meantime, work needed to complete calibration and validation of data records was getting done. More recently, however, the program reported a management dispute with respect to STAR participation in the development of ground system requirements and concept of operations needed to operationalize Suomi NPP and prepare for JPSS-1, potentially delaying the ground project's system requirements and definition review. The program recently told us that it was hopeful it would reach an agreement with STAR without needing to engage NESDIS management to clarify roles and responsibilities.

In response to our September 2011 audit report, NOAA planned to identify resources needed to complete all calibration and validation work within 18 months. JPSS staff, however, told us that 24 months was the program's nominal schedule for completing such

activities. The program's schedule indicated that 22 products will take from 27 to 48 months postlaunch to reach a stage where their accuracy has been established in a systematic and statistically robust way, representing global conditions. Higher priority data records—those needed for weather forecasting—will be validated and operationalized sooner.

In addition to prioritizing its schedule of activities, the program has addressed resource constraints by canceling NOAA-funded aircraft flights that would have collected atmospheric data for comparisons with Suomi NPP data. STAR scientists, who did not know of the decision until we asked them, considered the aircraft flights an essential calibration and validation activity. Finally, the program continues to negotiate to retain key Northrop Grumman expertise that would be lost with the termination of a remaining NPOESS contract supporting calibration and validation.

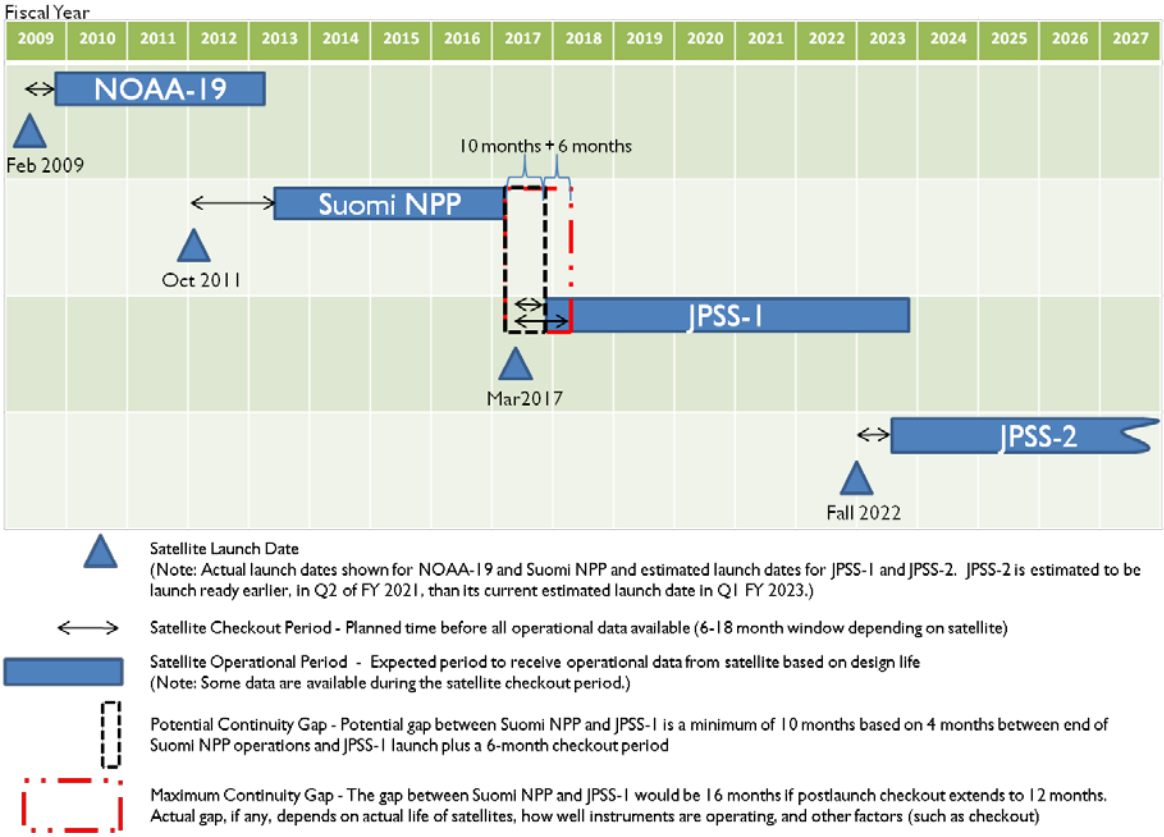
V. Assessment of Expected Data Gap Between Suomi NPP and JPSS-1

Over the course of the program to date, we have analyzed Suomi NPP and JPSS schedules to assess expected gaps in weather forecast data, a subset of all the environmental data to be collected by these satellites' instruments. In June 2011, we estimated an 18–30-month gap between Suomi NPP and JPSS-1, based on the status of the satellites' development at that time. In our September 2011 report, we estimated that the expected gap in useful satellite data had improved to between 9 and 21 months, in part due to an improved funding outlook for JPSS. Currently, we project a 10–16-month gap between Suomi NPP and JPSS-1 operational data (see figure 5).

In our current analysis, we assume a JPSS-1 launch in March 2017, which is 1 month later than what we assumed in our September 2011 assessment. The program is currently projecting a JPSS-1 launch in the second quarter of fiscal year 2017, a one-quarter slip from its previous estimate. We maintain a conservative outlook by assuming the launch will occur near the end of the quarter.

Our current data gap projection also assumes that 6 to 12 months of postlaunch activity will be necessary for JPSS-1 data to be sufficiently calibrated and validated for operational use. Given that Suomi NPP's design life is 5 years, it is possible that the program will not have Suomi NPP data to compare with JPSS-1 measurements. In that case, the program would need to use other space-borne assets, including any legacy NOAA polar satellites still operating (an increasingly remote possibility) and those of other agencies and international partners, as well as in situ data. This scenario would tend to extend the time needed to calibrate and validate JPSS-1data.

Figure 5. Potential Continuity Gaps for Polar-Satellite Operational Forecast Data



Source: OIG analysis of program data, as of June 6, 2012

It is also possible that Suomi NPP will continue to operate beyond its design life. NASA's launch of Suomi NPP proved to be very precise, with the result that fuel intended to propel the satellite into the proper orbit was conserved. The saved propellant may be used for an additional 7 years (a total of 14 years) of orbit maintenance maneuvers and prolong the usefulness of Suomi NPP—although the life of its command, control, and communications systems and, even more so, its instruments will likely be limiting factors. Further, Suomi NPP calibration and validation activities have had some early successes, particularly with the assimilation of ATMS data records into operational weather forecasting models. Given that JPSS-1 will fly the same instruments, this success favors a shorter postlaunch time period before JPSS-1 data may be used operationally.

In September 2011, we reported on activities within NOAA to use other sources of data to mitigate gaps and recommended that NOAA coordinate efforts from across its line offices to minimize the degradation of weather and climate forecasting. In response, NOAA indicated that it was looking at both foreign and commercial sources of data. However, NOAA has not yet fully developed a strategy for evaluating and selecting foreign data sources.

Recommendations

To guide JPSS toward successful program implementation, we recommend that the NOAA Deputy Under Secretary for Operations ensure that

1. Sufficient resources and attention are given to finalizing JPSS high-level requirements and completing system definition.

2. The program's acquisition strategy for JPSS-3 and JPSS-4 is determined, documented, and shared with the Department, OMB, and Congress.

3. NESDIS and the JPSS program quantify cost savings as part of its ongoing effort to determine the most efficient approach to processing environmental data records.

4. NESDIS determines whether an enterprise approach to developing and maintaining data products from its environmental satellites could achieve economies of scale and complement other efforts to modernize its system architecture.

5. Sufficient resources and attention are given to permanently filling key management positions.

To ensure that JPSS and other NOAA major system acquisition program cost estimates are reliable, the NOAA Deputy Under Secretary for Operations should

6. Direct the development of a policy that requires major system acquisition programs to adhere to cost-estimating best practices.

7. In the interim, ensure that cost-estimating best practices are more closely adhered to in the JPSS program and other major system acquisitions.

To manage risks inherent with JPSS' anticipated (flat) funding, the NOAA Deputy Under Secretary for Operations should ensure that

8. An independent cost estimate adequately tests the viability of the program's funding profile.

9. Stakeholders are sufficiently informed of unplanned schedule and capabilities tradeoffs, if needed, to meet surges in effort necessary for launches.

To use Suomi NPP data in operational forecasting, NOAA should continue actions taken in response to our September 2011 audit recommendations.

To prepare for an expected gap in polar satellite data, NOAA should continue actions taken in response to our September 2011 audit recommendations.

Summary of Agency Response and OIG Comments

In responding to our draft report, NOAA concurred with all of our recommendations. It also suggested factual and technical changes and made editorial comments in regard to certain aspects of our findings. See appendix B for the complete response.

We have made minor changes to the report where program documentation substantiated NOAA's recommended changes and the revisions provided a better understanding of the issues. Beyond those changes, we offer the following comments on NOAA's specific responses.

NOAA asserted that the program's prolonged formulation activities were attributable to "inadequate funding in FY 2011 and FY 2012" rather than the issues with governance structure and staffing we describe in the report. However, our discussion of these issues both in this and prior reports does acknowledge the funding challenges the program has experienced in FY 2010 and FY 2011. (In FY 2012, Congress funded JPSS with $924 million compared with its $1.07 billion budget request.)

NOAA suggested that part of our discussion of NOAA's cost-estimating process in finding II "misrepresents the confidence in the cost estimate." In particular, the agency objected to our findings about the differences in ground rules and assumptions between the NASA and NOAA cost estimates. Our analysis is supported by both program documentation and information we obtained from separate interviews of NOAA and NASA staff. Further, as described in this finding, the analysis of NOAA's cost-estimating process was necessarily limited to its activities in 2011. We told NOAA officials at our audit exit conference that it was possible some of the issues we identified may become less substantial as the cost estimate was refined in 2012 and going forward.

NOAA indicated that since we issued our draft report, a JPSS acquisition strategy meeting with NOAA and NASA leadership was held and NOAA plans to communicate with the Administration and Congress on such matters and use the information for future budget requests. We look forward to learning more about the strategy in our continuing oversight work.

Finally, NOAA indicated that in our discussion of the management of calibration and validation activities (finding IV, part D), our statements concerning the transition of responsibility to STAR do not reflect NESDIS management's view. Elsewhere in the response, NOAA indicates that this issue has no impact on the program. We would suggest that NESDIS management has a different view from JPSS project managers and that impact, both to JPSS and STAR, is described in the report.

Appendix A: Objectives, Scope, and Methodology

This audit was initiated in November 2011 as part of our FY 2012 work plan and in conjunction with our Top Management Challenges facing the Department of Commerce. Our objectives were the following:

1. Assess the adequacy of JPSS formulation activities, including development of requirements, schedule, and cost baselines.

2. Monitor the program's efforts to maintain continuity of polar satellite data from the afternoon orbit, specifically activities supporting Suomi NPP on-orbit operations and the development of JPSS-I.

To accomplish our first objective, we interviewed NOAA and NASA program managers and staff involved in program formulation, including contractors supporting such efforts. We also interviewed the independent cost estimate contractor and staff in NOAA's Office of the Chief Financial Officer, who oversaw the development of the independent cost estimate for JPSS and had knowledge pertaining to NOAA's budget formulation. In addition, we obtained information from the Department's Office of Budget. We examined program activities and documentation supporting baseline development and compared them with the following standards and best practices:

- NASA Space Flight Program and Project Management Requirements (NPR 7120.5D, including NASA Interim Directive 7120-97), March 2007

- GAO Cost Estimating and Assessment Guide, Best Practices for Developing and Managing Capital Program Costs (GAO-09-3SP), March 2009

- Department of Defense Standard: Work Breakdown Structures for Defense Materiel Items (MIL-STD-881C), October 2011

To accomplish our second objective, we interviewed JPSS program and project level staff from both NOAA and NASA. Our senior satellite analyst attended the American Meteorological Society Conference in January 2012, which included presentations from and interactions with JPSS program staff and scientists. We interviewed officials and staff from NOAA's Center for Satellite Applications and Research and the National Centers for Environmental Prediction. We reviewed and analyzed weekly and monthly program and project status reports and other documentation. Our fieldwork also included attending multiple JPSS program management reviews:

- monthly NOAA Program Management Councils

- monthly flight and ground system contractors' program management reviews

- NPP satellite acceptance review, March 6, 2012
- NPP operations transfer review, March 7, 2012
- JPSS program's system requirements review, May 22–24, 2012
- JPSS Key Decision Point 0 review, July 20, 2012

We reviewed internal controls significant within the context of our audit objectives: NOAA/NASA satellite acquisition program management policies and practices and program schedules (discussed in findings I and II) and program reviews (discussed in finding IV).

Although we could not independently verify the reliability of all the information we collected, we compared it with other available supporting documents to determine data consistency and reasonableness. From these efforts, we believe the information we obtained is sufficiently reliable for this report.

We performed our work in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence that provides 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.

We conducted our review from November 2011 through August 2012 under the authority of the Inspector General Act of 1978, as amended, and Department Organizational Order 10-13. We performed fieldwork at the following locations:

- NOAA headquarters in Silver Spring, Maryland
- JPSS program office in Lanham, Maryland
- Raytheon's facility in Aurora, Colorado
- Ball Aerospace Technology Corporation's facility in Boulder, Colorado
- NCEP headquarters in Camp Springs, Maryland
- the AMS Conference in New Orleans, Louisiana

Appendix B: Agency Response

UNITED STATES DEPARTMENT OF COMMERCE
The Deputy Under Secretary for Operations
Washington, D.C. 20230

MEMORANDUM FOR: Allen Crawley
Assistant Inspector General for Systems Acquisition and IT Security

FROM: David W. Titley, PhD 9/20
NOAA Deputy Under Secretary for Operations

SUBJECT: *Audit of the Joint Polar Satellite System: Continuing Progress in Establishing Capabilities, Schedules, and Costs Is Needed to Mitigate Data Gaps*
Draft OIG Audit Report

Thank you for the opportunity to comment on the Office of the Inspector General's draft audit report evaluating the Joint Polar Satellite System program. Our specific comments on the report's findings and recommendations are attached.

Attachment

Department of Commerce
National Oceanic and Atmospheric Administration
Comments on the Draft OIG Report Entitled,
"Audit of the Joint Polar Satellite System: Continuing Progress in Establishing Capabilities, Schedules, and Costs is Needed to Mitigate Data Gaps"
(Draft Report August 29, 2012)

General Comments

The Department of Commerce's National Oceanic and Atmospheric Administration (NOAA) appreciates the opportunity to review the Office of Inspector General's (OIG) draft report evaluating the Joint Polar Satellite System (JPSS) program. NOAA respectfully requests that the OIG acknowledge that JPSS exists in multiple stages of development. The overall system is still in its formulation phase, consistent with space acquisition practices. Decisions required for near-term missions have been made, and JPSS is executing to these plans. Planning for longer-term decisions (e.g., related to JPSS-1/2 follow-on missions) is underway, and those strategies and decisions will be made when needed.

NOAA believes the draft report highlights important issues. The discussion and negotiations are normal for a program as complex as JPSS. Clarifications to items that are incomplete or misstated are included.

NOAA Response to Recommendations

To guide JPSS toward successful program implementation, we recommend that the NOAA Deputy Under Secretary for Operations ensure that:

Recommendation 1: "Sufficient resources and attention are given to finalizing JPSS high-level requirements and completing system definition."

NOAA Response: We concur. The original JPSS Level 1 Requirements Document (L1RD) was signed in 2010 and the NOAA JPSS Office has been working to update the L1RD since January 2012. This update incorporates all the known changes to requirements and will serve as the system baseline as the Program moves to the System Definition Review. The draft document is currently in review and approval by the Deputy Under Secretary for Operations is expected in November 2012.

Recommendation 2: "The program's acquisition strategy for JPSS-3 and JPSS-4 is determined, documented, and shared with the Department, OMB and Congress."

NOAA Response: We concur. Implementation of this recommendation is underway. A joint Department/NOAA and NASA Acquisition Strategy Meeting was held on August 29, 2012, and NOAA is planning to share the acquisition strategy with OMB and Congress at a date to yet be determined.

Recommendation 3: "NESDIS and the JPSS program quantify cost savings as part of its

ongoing effort to determine the most efficient approach to processing environmental data records."

NOAA Response: We concur. Since Spring 2012, JPSS has been conducting an analysis of the most efficient way to process the environmental data records. As we continue to incorporate efficiencies we will quantify cost savings compared to the approach inherited from National Polar-orbiting Operational Environmental Satellite System (NPOESS). This is an ongoing process and not a one-time study. For example, in the 2012 program office estimate, NOAA incorporated many cost-savings into the program. The program will continue to revisit this issue.

Recommendation 4: "NESDIS determines whether an enterprise approach to developing and maintaining data products from its environmental satellites could achieve economies of scale and complement other efforts to modernize its system architecture."

NOAA Response: We concur. NESDIS is currently assessing approaches to define/direct Enterprise Ground Services architecture. NESDIS has set this is as a strategic priority, and is taking steps to complete this assessment by the second quarter of FY13.

Recommendation 5: "Sufficient resources and attention are given to permanently filling key management positions.

NOAA Response: We concur. Implementation of this recommendation is already under way. As noted in the report, the NESDIS Deputy Assistant Administrator for Systems position is vacant. This position announcement is currently open on USAJobs, with a close date of October 1, 2012. Filling this position is a priority for NESDIS and NOAA. NESDIS is also looking at ways to strengthen its corporate knowledge with the addition of two senior managers with expertise in Systems Engineering and Ground Systems. Within the NOAA JPSS Office, the Systems Engineer position and at least two additional systems engineering positions are expected to be filled by the end of the calendar year. The Budget Officer selection has been made, and the Budget Officer will start in the NOAA JPSS Office in October. These additional staff will allow JPSS adequately plan, manage, and execute the mission.

To ensure that JPSS and other NOAA major system acquisition program cost estimates are reliable, the NOAA Deputy Under Secretary for Operations should:

Recommendation 6: "Direct the development of a policy that requires major system acquisition programs to adhere to cost-estimating best practices."

NOAA Response: We concur. The Government Accountability Office (GAO) recently issued a report on cost estimating (GAO-12-629) and in NOAA's response, we indicated that NOAA would benefit from Commerce-level policies that ensure that NOAA's procedures are consistent with other Commerce bureaus' cost estimations. Those efforts are ongoing and NOAA expects to comply once the Department of Commerce has issued its guidelines and policy governing cost estimating.

Recommendation 7: "In the interim, ensure that cost-estimating best practices are more closely adhered to in the JPSS program and other major system acquisitions."

NOAA Response: We concur. JPSS will continue to use cost-estimating best practices, perform lessons learned before the next cost estimating update, and ensure our cost estimating methods are independently reviewed to verify adherence. For example, the JPSS kicked off the development of an update to the Cost Analysis Requirements Documents (CARD) in late June 2012, and will be completed and appropriately vetted by late Fall 2012. The requirements in the update will serve as input for the program estimate and independent cost estimate (ICE) planned for late 2012 / early 2013. The ICE will be led by the Department of Commerce Cost Analysis Division with support from the US Air Force Cost Analysis Agency Space Division. The updated CARD will reflect the Final Level 1 Requirements Document, as well as improved definition on the ground system as presented during the August Ground System requirements and Definition Review (GSRR / GSDR).

To manage risks inherent with JPSS' anticipated (flat) funding, the NOAA Deputy Under Secretary for Operations should ensure that:

Recommendation 8: "An independent cost estimate adequately tests the viability of the program's funding profile."

NOAA Response: We concur. An update to the FY 2011 independent cost estimate (ICE) is expected to be completed by March 2013.

Recommendation 9: "Stakeholders are sufficiently informed of unplanned schedule and capabilities tradeoffs, if needed, to meet surges in effort necessary for launches."

NOAA Response: We concur. The JPSS Office hosts several meetings to ensure that stakeholders are up-to-date on the status of the program and aware of any changes to JPSS capabilities or timelines. First, the Low-Earth Orbiting Requirements Working Group (LORWG) meets regularly and is the focal point for the Low-Earth Orbiting Satellite operational requirements. The LORWG is presently meeting every 2-3 weeks. Once the Level 1 Requirements Document is completed, the LORWG will meet less often since the meeting schedule is lifecycle-stage-dependent. Among their duties is to prepare impact statements responding to Low-Earth Orbiting satellite technical program changes that could impact customer satisfaction. The JPSS Coordination Group meets at least every two months to coordinate on the development, operation and sustainment of the JPSS (and Suomi NPP) Ground System. In addition, the JPSS Ground Division holds quarterly Customer Forums with teleconferences held in between these face-to-face meetings to discuss the program status and upcoming events with those who download and process the JPSS and NPP data. Finally unplanned schedule and capabilities trades are reported monthly at Governance Council meetings. NOAA intends to continue these meetings through the acquisition of the JPSS.

Recommendation 10: "To use Suomi NPP data in operational forecasting, NOAA should continue actions taken in response to our September 2011 audit recommendations."

NOAA Response: We concur. NOAA is already responding and tracking responses to the September 2011 OIG report.

Recommendation 11: "To prepare for an expected gap in polar satellite data, NOAA should continue actions taken in response to our September 2011 audit recommendations."

NOAA Response: We concur. NOAA is already responding and tracking responses to the September 2011 OIG report.

Department of Commerce
National Oceanic and Atmospheric Administration
Comments on the Draft OIG Report Entitled,
"Audit of the Joint Polar Satellite System: Continuing Progress in Establishing Capabilities, Schedules, and Costs is Needed to Mitigate Data Gaps"
(Draft Report August 29, 2012)

Recommended Changes for Factual/Technical Information

Page 3, first paragraph, second sentence:
The date noted for JPSS-2 launch, 2022, is a launch readiness date and not a launch date. Recommend inserting "readiness" after "…slated for launch."

Page 3, third paragraph, third sentence:
The prolonged formulation activities were mainly a result of inadequate funding in FY 2011 and FY 2012 and not because of a delayed governance structure and inadequate staffing. We recommend that more insight be provided as to why the OIG has characterized the delays in this way or delete the sentence.

Page 3, fourth paragraph, third sentence:
JPSS follows the best practices and policies of cost estimating; however, the JPSS is not a typical system in two substantive ways: a) it is a restructure of the NPOESS program, which required JPSS to inherit the elements of that program, and b) the JPSS is comprised of at least 2 different kinds of spacecraft with different instrument manifests. It is not like a typical NASA program that generally builds a one-of-a-kind satellite, and it is not like prior NOAA satellite programs where multiple satellites with the same instruments were acquired.
Page 3, fourth paragraph:
There is no evidence for the assertion that "efforts to operationalize Suomi NPP data have had mixed results thus far," and there is a factual error in the sentence that states "other data records will not be available for operational use until December 2013." The operational use of ATMS data by the NWS was on a schedule that was faster than any other assimilation of new satellite data in the past, and the calibration/validation of all of the data products is progressing well. In fact, all of the data products are available now in "beta" phase, and some are being used operationally now. Calibration/validation of the products will continue through the life of the program, and there are 40 environmental data records created from Suomi NPP data. Recommend clarification be added to describe what "mixed results" is referring to and clarification added to describe the status of the data products.

Page 5, first paragraph, fourth sentence:
Consistent with NPR 7120.5E, NASA Space Flight Program and Project Management Requirements, program baseline are established at Key Decision Point I, demonstrating sufficiency to begin implementation with established content, cost and schedule commitment. The allowable duration or period for the formulation phase varies across programs to accommodate feasibility assessments, risk assessments, buildup of teams/organizations, development of operations concept, establishment of high level requirements and success criteria, approval of plans, budgets, schedules, coordination and implementation of programs

controls, and other performance criteria. Recommend adding "which is consistent with NPR 7120.5E, NASA Space Flight Program and Project Management Requirements" after "…currently planned for July 2013."

Page 5, Table 1:
Recommend adding Suomi NPP to the row labeled, "satellites" in all three columns because the cost includes Suomi NPP. Also, recommend adding a new row labeled, "instruments" to indicate that the instrument list has not changed since the 2009 estimate, but only how they would be accommodated has changed. *Page 6, fourth paragraph, first sentence:*
The Ground System Block 1.5 review was delayed, but the Ground System Block 2.0 review was accelerated; so the overall result was a faster, more efficient schedule. Recommend clarification.

Page 10, first paragraph, fifth sentence:
Recommend adding clarification for "potential for requirements changes."

Page 12, second paragraph:
This paragraph contains only a portion of the cost-estimating process, and thus misrepresents the confidence in the cost estimate. The first three sentences of the paragraph are part of the estimating process and represent no issues, and the last two sentences are inaccurate in that, while program content may have evolved over time, there was no miscommunication between the agencies. For the 2012 POE, JPSS used NASA Planning, Programming, Budgeting, and Execution (PPBE) 14, which only had JPSS-2 and JPSS-3.Recommend deletion.

Page 13, second paragraph, second sentence:
Recommend deletion of "contrary to proposals."

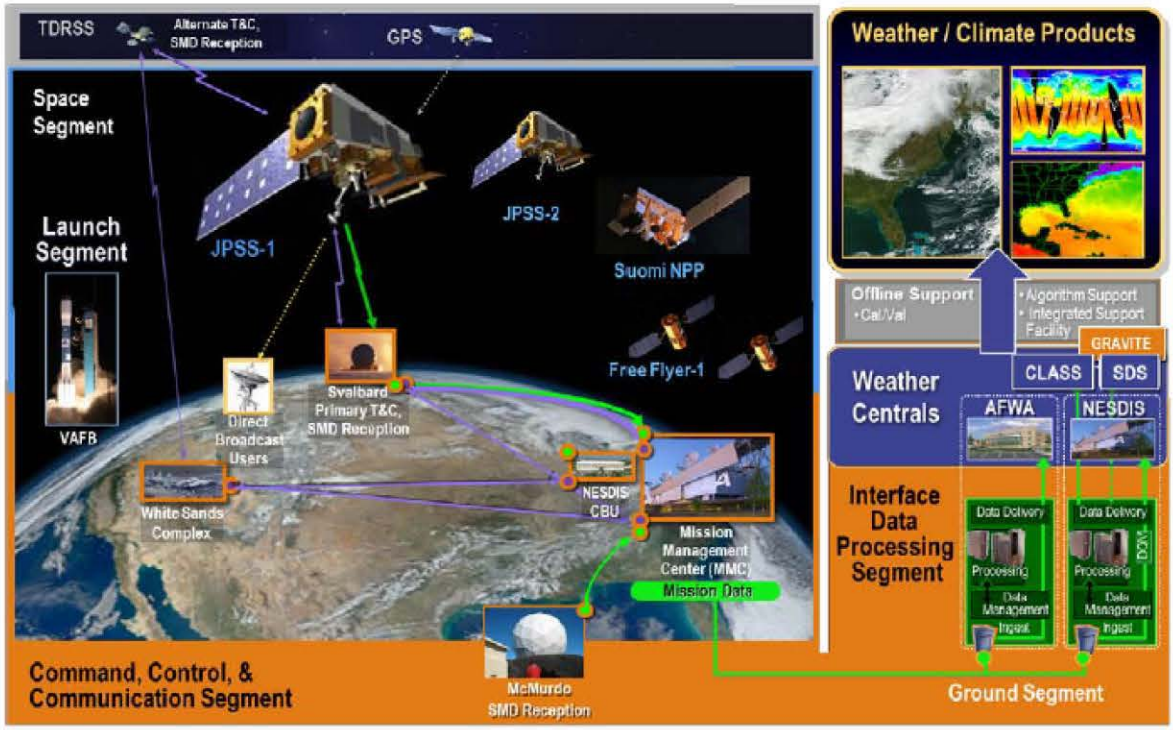
Page 13, third paragraph, first sentence:
Recommend providing clarification of "the potential to cost significantly more than what is currently budgeted."

Page 17, *fifth paragraph*:
This is an example of a description of an issue that has had no impact on the overall JPSS, and is part of a complex satellite acquisition. Recommend rewriting to clarify that discussions and negotiations between NESDIS offices has had no impact on the overall calibration/validation activities being completed.

Editorial Comments

Page 1, first paragraph of introduction, after last sentence:
Add additional sentence. The DOD is currently assessing requirements for their follow-on to the Defense Meteorological Satellite Program.

Page 1, Figure 1:
To illustrate the system and interfaces referenced throughout the presentation, recommend inserting the full JPSS Content as depicted below. The figure as shown in the current draft OIG report does not include the Tracking and Data Relay Satellite System (TDRSS) and White Sands link, as well as the appropriate references to Calibration/Validation and Algorithm Support. The OIG simplified this graphic without providing rationale for the omitted elements.



Page 2, second paragraph, fourth sentence:
The JPSS Program currently has projects that are in all Life Cycle Phases. Recommend adding "and operations" following "both formulation and implementation."

Page 2, fourth paragraph, first sentence:
Suomi NPP provides continuity for both NASA Earth Observing System (EOS) and NOAA Polar-orbiting Operational Environmental Satellite (POES), both of whose data are used operationally by the NOAA National Weather Service. Add "and NOAA's Polar-orbiting Operational Environmental Satellites (POES)" after "…NASA's Earth Observation System." Also, recommend substitution of "observing" for "observation" in the definition of NASA EOS.

Page 2, fourth paragraph, second sentence:
Add "and NASA EOS" after "…polar-orbiting operational environmental satellites."

Page 3, third paragraph and Page 7, third paragraph, second sentence:
Since the completion of the OIG report, JPSS has participated in an Acquisition Strategy Meeting with senior NOAA and NASA leadership. NOAA intends to communicate its strategy for maintaining the continuity of polar-orbiting operational satellite observations to the Administration and Congress, at a date to yet be determined, as well as use that information for future budget requests.

Page 7, first paragraph:
Need to reword first full sentence to "one such decision pertains to the ground system(s) that the

Free Flyers will require to meet their mission requirements, including the level of Information Technology (IT) security required for the mission."

Page 8, third paragraph, fifth sentence:
Add one word in the following sentence: "In June 2012, the acting Deputy Assistant Administrator for Systems…"

Page 11, third paragraph:
JPSS initially started with a product oriented Work Breakdown Structure (WBS); however, it was not the manner in which NASA was tracking the elements. Therefore, JPSS decided to adopt the NPR 7120.5E WBS to facilitate integration of cost estimates.

Page 14, first paragraph:
While the budget profile may not follow that of a true development program, NOAA was able to live within the artificially flattened profile by focusing on NPP operations and JPSS-1 - the remainder of the content was done in later years to fit the profile. One aspect that the Department of Commerce considered was the funding level Congress would fund, based on the House Appropriations Committee and Senate Appropriations Committee marks, as well as the actual FY 2012 appropriations. Given this, the Administration felt $900M plus the Restoration of Climate Sensors reflected a more realistic funding profile; one that would be more likely to receive full funding from Congress.

Page 15, second paragraph, first sentence:
The acceptance organization is incorrect. In March 2012, JPSS accepted Suomi NPP from the NASA NPP Project, not Ball Aerospace.

Page 16, third paragraph:
Replace "NDE" with "ESPC."

Page 17, fifth paragraph:
The statement, "JPSS staff believe that the transition will be more appropriate once data records and underlying algorithms have reached a more stable phase after the launch of JPSS-1" does not reflect management's view. NESDIS management, as well as comments from an Independent Review Team has encouraged the transition of science activities, a NESDIS core competency, to take place as soon as possible.

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