



## Testimony

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

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For Release on Delivery  
Expected at 10:00 a.m. EDT  
Thursday, April 23, 2009

# GEOSTATIONARY OPERATIONAL ENVIRONMENTAL SATELLITES

## Acquisition Has Increased Costs, Reduced Capabilities, and Delayed Schedules

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Highlights of [GAO-09-596T](#), a testimony before the Subcommittee on Energy and Environment, Committee on Science and Technology, House of Representatives

### Why GAO Did This Study

The Department of Commerce’s National Oceanic and Atmospheric Administration (NOAA), with the aid of the National Aeronautics and Space Administration (NASA), plans to procure the next generation of geostationary operational environmental satellites, called the Geostationary Operational Environmental Satellite-R series (GOES-R). GOES-R is to replace the current series of satellites, which will likely begin to reach the end of their useful lives in 2014. This series is considered critical to the United States’ ability to maintain the continuity of data required for weather forecasting through the year 2028.

GAO was asked to summarize its report being released today that (1) determines the status of the GOES-R program, (2) evaluates whether plans for the acquisition address problems experienced on similar programs, and (3) determines whether NOAA’s plan will be adequate to support current data requirements.

### What GAO Recommends

In its report, GAO recommended that the program take steps to improve management and oversight and determine whether and how to recover certain capabilities that were removed from the program. In comments on a draft of this report, the Acting Secretary of Commerce agreed with GAO’s recommendations and stated that the agency plans to implement them.

To view the full product, including the scope and methodology, [click on GAO-09-596T](#). For more information, contact David A. Powner, (202) 512-9286, [pownerd@gao.gov](mailto:pownerd@gao.gov).

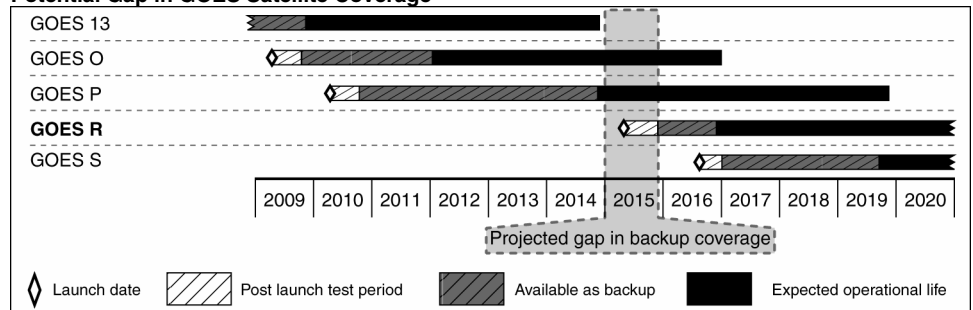
## GEOSTATIONARY OPERATIONAL ENVIRONMENTAL SATELLITES

### Acquisition Has Increased Costs, Reduced Capabilities, and Delayed Schedules

#### What GAO Found

NOAA has made progress on the GOES-R acquisition, but the program’s cost, schedule, and scope have changed. The GOES-R program has awarded development contracts for key instruments and plans to award contracts for the spacecraft and ground segments by mid-2009. However, after reconciling program and independent cost estimates, the program established a new cost estimate of \$7.67 billion—a \$670 million increase from the prior \$7 billion estimate. The program also reduced the number of products the satellites will produce from 81 to 34 and slowed the delivery of these products in order to reduce costs. More recently, the program also delayed key milestones, including the launch of the first satellite, which will likely be delayed from December 2014 until at least May 2015. This delay in the GOES-R launch runs counter to NOAA’s policy of having a backup satellite in orbit at all times and could lead to gaps in satellite coverage if GOES-O or P fail prematurely (see graphic below).

Potential Gap in GOES Satellite Coverage



Source: GAO analysis of NOAA data.

GOES-R has taken steps to address lessons from other satellite programs, but important actions remain to be completed. These actions include ensuring sufficient technical readiness of the system’s components prior to key decisions. However, technical challenges remain on the ground segment and instruments, the program did not perform a comprehensive review after rebaselining a critical instrument, and it has not documented all of the reasons for cost overruns. Until these issues are addressed, NOAA faces an increased risk that the GOES-R program will repeat the same mistakes that have plagued other satellite programs.

While NOAA and the science community expressed a continuing need for advanced products that were removed from the program, the agency has not developed plans or a timeline for meeting these requirements. Until a decision is made on whether and how to proceed in providing the advanced products, key system users, such as weather forecasters, will not be able to meet their goals for improving the accuracy of severe weather warnings.

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Mr. Chairman and Members of the Subcommittee:

Thank you for the opportunity to participate in today's hearing on our nation's Geostationary Operational Environmental Satellite-R (GOES-R) series. The GOES-R series is to replace the current series of satellites, which will likely begin to reach the end of their useful lives in approximately 2014. This new series is expected to mark the first major technological advance in GOES instrumentation since 1994. It is also considered critical to the United States' ability to maintain the continuity of data required for weather forecasting through the year 2028. As requested, this statement summarizes our report being released today that (1) determines the status of the program, (2) evaluates whether plans for the GOES-R acquisition address problems experienced on similar programs, and (3) determines whether National Oceanic and Atmospheric Administration's (NOAA) plan to address the capabilities that were planned for the satellites, but then removed, will be adequate to support current data requirements.<sup>1</sup>

In preparing this testimony, we relied on our work supporting the accompanying report. That report contains a detailed overview of our scope and methodology. In addition, we updated factual information on satellite launch schedules as warranted. All of our work for this report was performed 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.

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<sup>1</sup>GAO, *Geostationary Operational Environmental Satellites: Acquisition is Under Way, but Improvements Needed in Management and Oversight*, [GAO-09-323](#) (Washington, D.C.: April 2, 2009).

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## Background

NOAA operates GOES as a two-satellite system that is primarily focused on the United States. These satellites are uniquely positioned to provide timely environmental data about the earth's atmosphere, its surface, cloud cover, and the space environment to meteorologists and their audiences. They also observe the development of hazardous weather, such as hurricanes and severe thunderstorms, and track their movement and intensity to reduce or avoid major losses of property and life. Furthermore, the satellites' ability to provide broad, continuously updated coverage of atmospheric conditions over land and oceans is important to NOAA's weather forecasting operations.

To provide continuous satellite coverage, NOAA acquires several satellites at a time as part of a series and launches new satellites every few years (see table 1). NOAA's policy is to have two operational satellites and one backup satellite in orbit at all times.

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**Table 1: Summary of the Procurement History of GOES**

Series name	Procurement duration <sup>a</sup>	Satellites
Original GOES <sup>b</sup>	1970-1987	1, 2, 3, 4, 5, 6, 7
GOES I-M	1985-2001	8, 9, 10, 11, 12
GOES-N	1998-2010	13, O, P, Q <sup>c</sup>
GOES-R	2008-2016	R, S

Source: GAO analysis of NOAA data.

<sup>a</sup>Duration includes time from contract award to final satellite launch.

<sup>b</sup>The procurement of these satellites consisted of four separate contracts for (1) two early prototype satellites and GOES-1, (2) GOES-2 and -3, (3) GOES-4 through -6, and (4) GOES-G (failed on launch) and GOES-7.

<sup>c</sup>NOAA decided not to exercise the option for this satellite.

Four GOES satellites—GOES-10, GOES-11, GOES-12, and GOES-13—are currently in orbit. Both GOES-11 and GOES-12 are operational satellites, with GOES-12 covering the east and GOES-11 the west. GOES-13 is currently in an on-orbit storage mode. It is a backup for the other two satellites should they experience any degradation in service. GOES-10 is at the end of its service life, but it is being used to provide limited coverage of South America. The others in the series, GOES-O and GOES-P, are planned for launch

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over the next 2 years.<sup>2</sup> NOAA is also planning the next generation of satellites, known as the GOES-R series, which are planned for launch beginning in 2015.

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## GOES-R Program—An Overview

NOAA plans for the GOES-R program to improve on the technology of prior series, in terms of both system and instrument improvements. The system improvements are expected to fulfill more demanding user requirements by updating the satellite data more often and providing satellite products to users more quickly. The instrument improvements are expected to significantly increase the clarity and precision of the observed environmental data. NOAA originally planned to acquire six different types of instruments.

In September 2006, however, NOAA decided to reduce the scope and technical complexity of the GOES-R program because of expectations that total costs, which were originally estimated to be \$6.2 billion, could reach \$11.4 billion.<sup>3</sup> Specifically, NOAA reduced the minimum number of satellites from four to two, cancelled plans for developing a critical instrument—the Hyperspectral Environmental Suite (which reduced the number of planned satellite products from 81 to 68), and divided the Solar Imaging Suite into two separate acquisitions. The agency estimated that the revised program would cost \$7 billion. In addition to the reductions in scope, NOAA also delayed the launch of the first satellite from September 2012 to December 2014.

NOAA is solely responsible for GOES-R program funding and overall mission success. However, since it relies on the National Aeronautics and Space Administration's (NASA) acquisition experience and technical expertise to help ensure the success of its

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<sup>2</sup>Satellites in a series are identified by letters of the alphabet when they are on the ground and by numbers once they are in orbit.

<sup>3</sup>GAO, *Geostationary Operational Environmental Satellites: Additional Action Needed to Incorporate Lessons Learned from Other Satellite Programs*, [GAO-06-1129T](#) (Washington, D.C.: Sept. 29, 2006) and *Geostationary Operational Environmental Satellites: Steps Remain in Incorporating Lessons Learned from Other Satellite Programs*, [GAO-06-993](#) (Washington, D.C.: Sept. 6, 2006).

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programs, NOAA implemented an integrated program management structure with NASA for the GOES-R program. Within the program office, there are two project offices that manage key components of the GOES-R system—the flight and ground segment project offices. The flight project office, managed by NASA, is responsible for awarding and managing the spacecraft segment contract, delivering flight-ready instruments to the spacecraft segment contractor for integration onto the satellites, and overseeing the systems engineering and integration. The ground segment project office, managed by NOAA, oversees the ground contract, satellite data product development and distribution, and on-orbit operations of the satellites.

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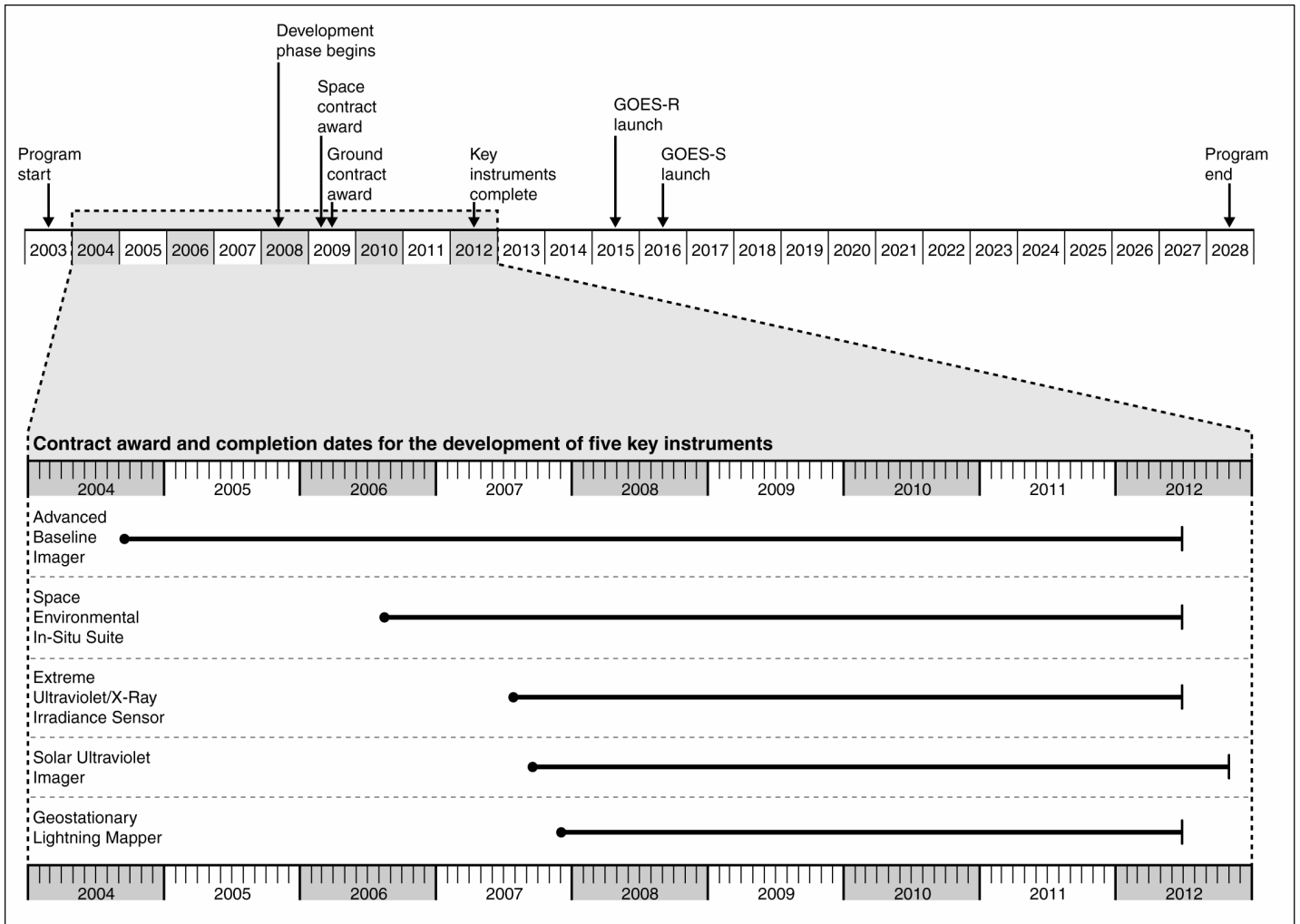
## GOES-R Is in Development, but Costs Have Increased, Envisioned Functionality Has Been Reduced, and Schedules Have Been Delayed

NOAA and NASA have made progress on the GOES-R program. In January 2008, NOAA approved the program's move from the preliminary design and definition phase to the development phase of the acquisition life cycle. This approval also gave the program the authority to issue the requests for proposals for the spacecraft and ground segment projects—which it did in January 2008 and May 2008, respectively. The program office plans to award the prime contract for the spacecraft segment in May 2009 and the contract for the ground segment in June 2009. In addition, between September 2004 and December 2007, the GOES-R program awarded contracts for the development of five key instruments.<sup>4</sup> These instruments are currently in varying stages of development. Figure 1 depicts the schedule for both the program and key instruments.

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<sup>4</sup>A sixth instrument, the Magnetometer, is to be developed as part of the space segment contract.

**Figure 1: Planned Schedule for GOES-R Program and Key Instruments**



Source: GAO analysis of NOAA data.

## GOES-R Cost Estimate Has Increased, Envisioned Functionality Has Been Reduced, and Key Milestones Have Slipped

NOAA has made several important decisions about the cost, scope, and schedule of the GOES-R program. After reconciling the program office’s cost estimate with an independent cost estimate, the agency established a new program cost estimate of \$7.67 billion, an increase of \$670 million from the previous estimate. Agency officials plan to

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revisit this cost estimate after the spacecraft and ground segment contracts are awarded but stated that it was developed with a relatively high level of confidence and that they believe that any adjustments would be well within the \$7.67 billion program budget.

To mitigate the risk that costs would rise, program officials decided to remove selected program requirements from the baseline program and treat them as options that could be exercised if funds allow. These requirements include the number of products to be distributed, the time to deliver the remaining products (product latency), and how often these products are updated with new satellite data (refresh rate). Specifically, program officials eliminated the requirement to develop and distribute 34 of the 68 envisioned products, including aircraft icing threat, turbulence, and visibility. Program officials explained that these products are not currently being produced by legacy GOES satellites; they are new products that could be produced from the advanced GOES-R instruments. In addition, the program slowed planned product latency on the remaining products by as much as 10 minutes for hurricane intensity and 6 minutes for volcanic ash detection and height. It also reduced the refresh rates on these products by as much as 55 minutes for sea surface temperatures, cloud top observations, and vertical moisture profiles in the atmosphere. Program officials included the restoration of the products, latency, and refresh rates as options in the ground segment contract—items that could be acquired at a later time.

NOAA also delayed GOES-R program milestones including the dates for issuing the requests for proposals by up to 6 months and awarding the contracts for the spacecraft and ground segments by 12 and 10 months, respectively. The dates when the satellites would be available for launch have also slipped by 4 months, with the first satellite launch now scheduled for April 2015. Program officials attributed these delays to providing more stringent oversight before releasing the requests for proposals, additional time needed to evaluate the contract proposals, and funding reductions in fiscal year 2008.

Recent events have raised doubts about the feasibility of the GOES-R launch date. Specifically, after the spacecraft segment



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contract was awarded and then protested in December 2008, NASA decided to re-evaluate the proposals. NASA now plans to re-award the contract in May 2009. Because NASA has agreed to a 72-month development cycle for the spacecraft segment (from contract award date to launch readiness), the launch date of GOES-R will likely be delayed until at least May 2015.

Any delays in the launch of the first GOES-R satellite run counter to NOAA's policy of having a backup satellite in orbit at all times and could lead to gaps in satellite coverage. This policy proved useful in December 2008, when NOAA lost communication with GOES-12, but was able to use GOES-13 as an operational satellite until communication was restored. However, beginning in November 2014, NOAA expects to have two operational satellites in orbit (O and P), but it will not have a backup satellite in place until GOES-R is launched. If NOAA experiences a problem with either of its operational satellites before GOES-R is in orbit, it will need to rely on older satellites that are beyond their expected operational lives and therefore may not be fully functional.

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## The GOES-R Program Office Has Taken Steps to Address Lessons Learned from Other Satellite Programs, but Important Actions Remain

GOES-R has taken steps to address lessons from other satellite programs. These actions include ensuring sufficient technical readiness of the spacecraft and ground segments prior to awarding the contracts. However, key risks remain and important actions remain to be completed in selected areas. Specifically, key technology risks remain—affecting both the ground segment and the instruments. While the hardware that is to be used for the ground segment is mature, key components have not previously been integrated. In addition, the program office has identified the Advanced Baseline Imager and the Geostationary Lightning Mapper instruments as having a high level of risk associated with cost due in part to the technical challenges posed by each instrument. Program officials reported that they have sufficient management reserves to address these risks.

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To manage such risks, NOAA uses earned value management,<sup>5</sup> a proven means for measuring progress against cost and schedule commitments and thereby identifying potential cost overruns and schedule delays early, when the impact can be minimized. Two key aspects of this process are (1) conducting comprehensive integrated baseline reviews to obtain agreement from stakeholders on the value of planned work and validate the baseline against which variances are calculated and (2) using monthly variance reports to provide information on the current contract status, the reasons for any deviations from cost or schedule plans, and any actions taken to address these deviations.

To its credit, the GOES-R program office is using earned value management to oversee the key instrument contracts and plans to use it on the spacecraft and ground segment contracts. To date, the program office has performed integrated baseline reviews on the instruments and obtains and reviews variance reports for each of the instruments. However, the program's integrated baseline review for the Advanced Baseline Imager did not include a review of schedule milestones, the adequacy of how tasks are measured, and the contractor's management processes. Further, the variance reports for two instruments—the Advanced Baseline Imager and the Geostationary Lightning Mapper—do not describe all of the significant variances. Program officials explained that they meet with the contractor on a monthly basis to discuss all of the variances, but they were unable to provide documentation of these discussions or the reasons for, impact of, or mitigation plans for the variances. As a result of these shortfalls, the program office has less assurance that key instruments will be delivered on time and within budget, and it is more difficult for program managers to identify risks and take corrective actions.

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<sup>5</sup>Earned value management is a project management approach that, if implemented appropriately, provides objective reports of project status, produces early warning signs of impending schedule delays and cost overruns, and provides unbiased estimates of a program's total costs.

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## NOAA Has Not Developed Plans for Meeting Requirements for Advanced Products

Before it was cancelled in September 2006, the Hyperspectral Environmental Suite was originally planned as part of the GOES-R satellite series to meet requirements for products that are currently produced by GOES satellites as well as new technically-advanced products not currently produced by GOES satellites. NOAA still considers these requirements to be valid, and NOAA and the science community still have a need for the advanced products.

NOAA had planned to use the new sounding products to improve its performance goals, such as helping to increase the lead times associated with severe thunderstorm warnings from an average of 18 minutes in 2000 to as much as 2 hours by 2025, and helping to increase the lead times associated with tornado warnings from an average of 13 minutes in 2007 to as much as 1 hour by 2025.<sup>6</sup> In addition, NOAA had planned to use the new coastal waters imaging products to provide more accurate and quantitative understanding of areas for which NOAA has management responsibilities.<sup>7</sup> In particular, the coastal water imaging products could have been used to predict and monitor the growth, spread, severity and duration of harmful algal blooms. Recent studies suggest that harmful algal blooms are occurring more frequently because of climate change.

NOAA, NASA, and the Department of Defense assessed alternatives for obtaining advanced sounding and coastal water imaging products from a geostationary orbit. The results of the analysis recommended that NOAA work with NASA to develop a demonstration sounder to fly on an as-yet undetermined satellite and to evaluate other options for coastal waters imaging. NOAA plans to assess the technical feasibility of various options and to

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<sup>6</sup>In addition to advanced sounding, other activities such as improvements in radar technologies are expected to help improve lead times.

<sup>7</sup>While current and future satellite systems provide selected coastal waters images, they lack the resolution, sampling frequency, and spectral information (field of vision) needed to monitor coastal areas and estuaries.

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have the National Research Council make recommendations on long-term options for coastal water imaging.

However, NOAA has not defined plans or a timeline for addressing the requirements for advanced products. Further, agency officials were unable to estimate when they would establish plans to fulfill the requirements. Until a decision is made on whether and how to provide the advanced products, key system users will not be able to meet their goals for improving the lead times or accuracy of severe weather warnings, and climate research organizations will not obtain the data they need to enhance the science of climate, coastal, environmental, and oceanic observations.

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## Implementation of Recommendations Could Improve Management and Oversight

In our report, we are making three recommendations that, if implemented, could improve the management and oversight of the GOES-R acquisition. These are: ensuring that any rebaselining of a key instrument includes an assessment of milestones, adequacy of resources, task and technical planning, and management processes; ensuring that reasons for cost and schedule variances are fully disclosed and documented; and, if feasible, developing a plan and timeline for restoring the advanced capabilities removed from the program.

In written comments on a draft of this report, the Department of Commerce agreed with our findings and recommendations and outlined steps it is taking to implement them. The department also provided technical comments on the report, which we incorporated as appropriate.

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In summary, NOAA has made repeated and continuing efforts to learn from problems experienced on other satellite programs. The GOES-R satellite series is now in development, but program costs have increased, the scope of the program has been reduced, and schedules have been delayed. Further, unless the program exercises

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contract options, key benefits in terms of new products and faster data updates will not be realized. Of particular concern are the three years of launch delays since 2006. In addition, recent events make it likely that the launch of GOES-R will continue to slip, which increases the risk of having gaps in satellite coverage. Until NOAA and NASA act to address this risk, the United States' ability to maintain the continuity of data required for weather forecasting is in jeopardy. In addition, NOAA has not yet developed a plan or a timeline for recovering the advanced capabilities that were removed. Until such decisions and plans are made, the geostationary user community may not be able to make significant improvements in their severe weather forecasts, or their ability to monitor our coastal environments.

Mr. Chairman and members of the Subcommittee, this concludes our statement. We would be pleased to respond to any questions that you or other members of the Subcommittee may have at this time.

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## Contact and Staff Acknowledgments

If you have any questions on matters discussed in this testimony, please contact David A. Powner at (202) 512-9286 or by e-mail at [pownerd@gao.gov](mailto:pownerd@gao.gov). Other key contributors to this testimony include Colleen M. Phillips, Assistant Director; Carol Cha; William Carrigg; Neil Doherty; Franklin Jackson; Kaelin Kuhn; Lee McCracken; and Eric Winter.

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