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Stormy outlook for weather satellites

A conversation with Sean O'Keefe

New thrust for solar electric propulsion

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Stormy outlook

Satellites operated by NOAA enable timely predictions of storms, flooding, and other critical hazards, allowing preparations and evacuations that save lives, health, and property in affected areas. The public has grown to rely on such capabilities and even take them for granted. Now, however, as these satellites and their military counterparts grow older, looming budget cuts threaten to create dangerous gaps in the coverage they provide.

MetOp-B waits to be encapsulated in the Soyuz rocket fairing.

by James W. Canan
Contributing writer

As superstorm Sandy headed west over the ocean last fall, Earth-scanning satellites in near-polar and geosynchronous orbits provided the images and information that enabled meteorologists to predict with spot-on accuracy the storm's path, intensity, speed, landfall areas, and impact. Sandy hit the U.S. hard, but its extensive damage to people, property, and quality of life along the east coast would almost certainly have been much worse without the timely alerts, advance preparations, and evacuations that the satellites made possible.

The performance of these so-called weather satellites, launched by NASA and operated by the National Oceanic and Atmospheric Administration (NOAA), is a prime example of the pivotal role that spacecraft play in weather forecasting and in managing many aspects of life on Earth amid the vagaries of apparent climate change. The satellites peer at the planet around the clock and transmit a constant stream of data on what is happening in the atmosphere and on land and sea, including changes in temperature, cloud formations, wind patterns, and ocean currents. Their output is the essence of sophisticated computer models that give rise to round-the-clock forecasts.

"Accurate forecasts and severe weather alerts on television and radio, on web pages, and smart phone 'apps' all rely on NOAA satellite data," declares a NOAA document. The satellites "guard the nation from unexpected severe weather such as hurricanes, winter storms, and even solar storms, and are critical to monitoring and predicting environmental events such as El Niño and La Niña, coral bleaching, ocean acidification, and algal blooms," it says.

Now looms a dangerous threat to the quality of weather forecasting and of life on

for weather satellites

Earth. Some of the meteorological satellites are old and running out of time. Replacements are being developed but probably will not be deployed in time to sustain the high quality of coverage that mankind has come to rely on and take for granted. Unless forestalled, the projected gap in coverage will occur in just a few years and extend for several more. This would sharply degrade the accuracy and timeliness of weather forecasts vital to the agricultural, maritime, transportation, and energy sectors, among others, and to the nation's economy and standard of living in general.

NOAA's National Environmental Satellite, Data, and Information Service (NESDIS) operates three geostationary operational environmental satellites (GOES) and uses data from the European Meteorological Operational, or MetOp, satellite as well. NOAA also is in charge of three Polar Operational Environmental Satellites (POES) circling the planet in north-south, low Earth orbits 540 mi. high, working in concert with Defense Meteorological Support Program (DMSP) spacecraft on similar tracks.

Procured and launched by NASA, the NOAA-operated satellites are primary producers of data for the National Weather Service's weather prediction models, which

Forecasts fostered by POES are used by the farming, energy, transportation, fishing, and tourism sectors.

provide high-confidence forecasts 2-7 days ahead. It has been estimated that timely forecasts fostered by the POES satellites alone are worth up to $8 billion a year to the farming, energy, transportation, fishing, and tourism sectors of the U.S. economy.

Imagery and funding falter

The money picture for weather satellites is not rosy. Critics warn that the multiyear dollar caps imposed by the Obama administration on programs for new geosynchronous and polar satellites likely will not allow for enough funding to cover their costs, and will result in their deferred development and deployment.

This would spell big trouble. GOES satellites spot and track severe weather, such as tornadoes and hurricanes, over the U.S. mainland. They also keep an eye on tropical storms and hurricanes over broader areas, from the west coast of Africa to the eastern and gulf coasts of the U.S., and from the far Pacific to America's West Coast. The GOES constellation, which also monitors solar activity, seems in good enough shape at the moment, but its satellites are wearing down and have been troublesome.

As Sandy approached the eastern U.S. last fall, the GOES-13 satellite covering the affected area (GOES East) faltered. Its imagery and data streams on temperatures and other phenomena became spotty. NOAA substituted the backup GOES-14 spacecraft, parked in 'orbital storage mode,' for the wayward GOES-13. If GOES-14 too had gone bad, the nation's weather observation and forecasting system would have taken a big hit.

The faulty satellite returned to operation after a troubleshooting team of engineers from NOAA, Boeing, and ITT fixed a vibration problem. But the malfunction portended more of the same in the GOES constellation and lent urgency to the GOES-R Series, a program conceived by NOAA to develop replacement satellites.

Cloudy forecast for GOES-R?

GOES-R deployment is slated to begin in late 2015. The satellites are expected to provide much sharper and more frequent images as well as greater numbers of atmospheric observations. They will also feature a new geostationary lightning mapper that will carry out, for the first time, continuous surveillance of all lightning activity throughout the Americas and adjacent oceans.

The Obama administration put a cost cap of $10.9 billion on the Lockheed Martin GOES-R program, presumably enough to pay for four new satellites and their instruments, operations, and launches through 2036. Last November the program got good marks in its mission-critical design review: Noting that "severe weather was again a major story in America this year," Mary Kicza, who heads NESDIS, said the success of the design review "gives us confidence that the GOES-R program's development is progressing well."

Even so, an independent review team (IRT), formed by the Dept. of Commerce (DOC) to examine all NOAA satellite programs, reported last summer that GOES-R still had major funding and oversight problems. The IRT gave the program slightly less than a 50/50 chance of meeting its scheduled launch date in late 2015.

At the same time, Kathryn Sullivan, deputy administrator of NOAA, cautioned Congress against shortchanging weather satellite programs in annual appropriations. Those programs "require stable budgets if they are to stay within their cost, schedule, and performance baselines," she said. "We must maintain [the] schedule to ensure that each satellite is ready for launch before its predecessor satellite reaches the end of its life; otherwise, we will have gaps in coverage that will erode the accuracy and reliability of the forecasts, watches, and warnings that our nation has come to rely upon."

JPSS takes hits

All things considered, GOES-R seems in better shape than the Joint Polar Satellite System program NOAA conceived to sustain transpolar coverage without interruption. JPSS-1, the first in this series, is scheduled for launch by early 2017, a target date that looks less and less likely as time goes by. JPSS-1 took a big budget hit early on, and its funding is only now beginning to meet initial hopes and expectations. But the damage was done. "Unfortunately, funding shortfalls have posed challenges to the [JPSS-1] satellite's development," a NOAA spokesperson says.

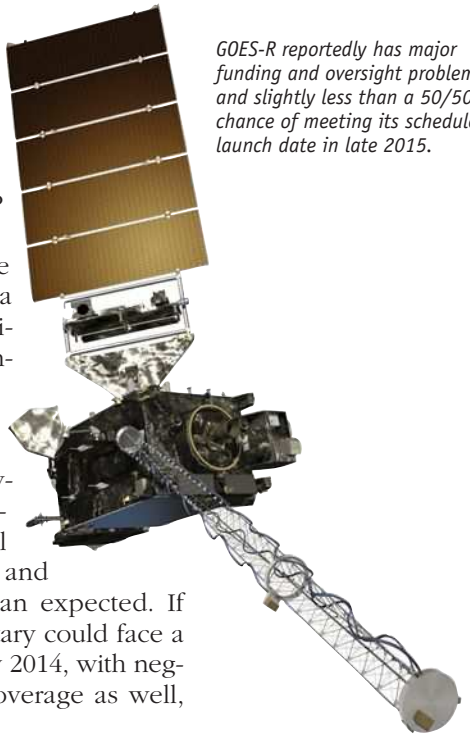
The administration's JPSS budget proposal for the current fiscal year put a $12.9-billion cap on the program through 2028, including money already spent on it. The administration claims that the cap will allow for full funding of the development, launch, operations, and ground systems for five satellites, but many officials and observers doubt this.

Troubled heritage

JPSS-1 also has a negative heritage. Its predecessor, NPOESS (National Polar Orbiting Environmental Satellite System), was initiated with high promise in 2002 but had a difficult, overly expensive development and was cancelled in 2010 because of unacceptable cost overruns, technical problems, and launch schedule setbacks.

NPOESS was designed as a constellation of satellites that would observe Earth continuously in early morning, midmorning, and afternoon orbits. The first satellite was scheduled for launch in 2008, a date that would have precluded a coverage gap.

At its inception, NPOESS was heralded as a joint NOAA/DOD consolidated program that would satisfy both civilian and military requirements for meteorological observations from space. NPOESS spacecraft were expected to replace and greatly improve upon the NOAA/NASA POES system and the Pentagon's DMSP satellites.



GOES-R reportedly has major funding and oversight problems and slightly less than a 50/50 chance of meeting its scheduled launch date in late 2015.

Lacking NPOESS, the DOD now plans to launch a new DMSP-19 meteorological satellite in 2014 and another, DMSP-20, if it is needed later on. But this timetable for maintaining military meteorological coverage is by no means certain. Currently operational DMSP satellites are old and may well falter sooner than expected. If that happens, the U.S. military could face a gap in weather coverage by 2014, with negative spinoff for civilian coverage as well, officials say.

The administration had planned to ensure continuous Earth-scanning coverage by relying on DOD spacecraft for early morning observations, the European satellite for midmorning data, and JPSS for afternoon surveillance. Implementing this plan was considered critical to maintaining and enhancing the data fundamental to forecasting weather and preparing for the worst that it might bring.

Now the plan has gone to pieces. The JPSS program timetable looks dicey, and DOD has decided not to follow through in developing new meteorological satellites to replace its aging DMSP spacecraft.

NPP Suomi: A bright spot

NPOESS was not a total washout. Before it was called off, the program gave rise to the NPOESS Preparatory Project Suomi (NPP Suomi) meteorological satellite, which has lived up to its promise. Originally designed solely as a technology demonstrator to test sensors developed for NPOESS, the Suomi spacecraft was inherited by the JPSS program office and pressed into operational service as a bridge to the first JPSS satellite. Its cost is included in the $12.9 billion projected for the JPSS program as a whole.

JPSS-1 will incorporate technologies developed for Suomi. The development and launch timetable of the JPSS program, described by NASA as "the restructured civilian portion of NPOESS," remains uncertain. The Suomi satellite went into operational service in late 2011 and is expected

Electromagnetic interference testing of the NPP satellite was conducted at the Ball Aerospace facility.

to cease functioning in October 2016. Having reviewed NOAA satellite programs, the General Accountability Office predicted a gap in Earth observational coverage of 17-53 months from the end of Suomi service to the operational onset of JPSS-1.

Originally, NOAA and NASA agreed on a plan to develop, test, and launch the first and second JPSS satellites by the end of 2014 and the end of 2017, respectively. But JPSS program funding was cut, causing NOAA to stretch the development of the first JPSS satellite and transfer some of its available funds to keeping Suomi on track. As a result, JPSS-1 and JPSS-2 are not expected to go into orbit until early 2017 and late 2022, respectively.

Funding, contractors, and instruments

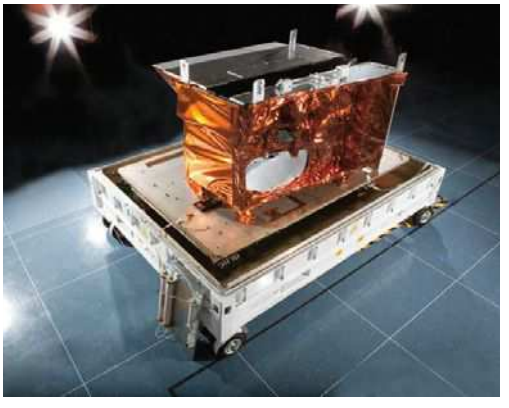
In its FY13 appropriations bill, the Senate Appropriations Committee proposed removing NOAA as the middleman for acquiring meteorological satellites. NASA has long been NOAA's purchasing agent for satellites. NOAA sets their technical and operational requirements, receives the money appropriated for their acquisition, and transfers it to NASA. As proposed by the Appropriations Committee, NOAA would continue to operate the spacecraft, but the appropriated funds would bypass NOAA and go directly to NASA.

Sen. Barbara Mikulski (D-Md.), who headed an appropriations subcommittee at the time, said the panel had become impatient with repeated cost overruns on NOAA's satellite programs, most notably JPSS. Mikulski, who now heads the full committee, also declared that DOC and NOAA "need to get their act together."

Ball Aerospace is prime contractor for the JPSS spacecraft and is under contract for the satellite's ozone mapping and profiler suite as well. NASA awarded contracts to Raytheon Space and Airborne Systems for the visible infrared imager radiometer suite (VIIRS) instrument on JPSS-1, to Raytheon Intelligence and Information Systems for the JPSS ground system, to Northrop Grumman Electronic Systems for the satellite's advanced technology microwave sounder (ATMS), and to ITT Exelis for the crosstrack infrared sounder (CrIS) instrument.

The instruments "form the backbone of space-based observations used for weather forecasting and environmental and climate monitoring," said a NASA statement in August 2012. The agency noted that the ATMS and CrIS "will be used as input for numerical weather prediction models, essential for weather forecasts beyond three days."

VIIRS will provide imagery "essential for monitoring severe weather in areas like Alaska, and for detecting and tracking volcanic ash and wildfires." It will also "gather data on a wide range of Earth's properties, including the atmosphere, clouds, radiation…clear-air land and water surfaces, and sea surface temperature," NASA noted.



VIIRS, a scanning radiometer, collects visible and infrared imagery and radiometric measurements of the land, atmosphere, cryosphere, and oceans.

Real risks, critical decisions

Raytheon has warned that downgrading the timeliness and accuracy of weather forecasting would endanger "lives, property, and critical infrastructure" and that "advance warning of extreme events would be significantly diminished, as would the understanding of storm surge and flood potential—making it more difficult to conduct safe and strategic evacuations."

Moreover, Raytheon says, "polar-orbiting satellites provide the only weather in-

formation for large swaths of the planet and are thus particularly important for overseas military operations."

GAO reported last year that NOAA "has made progress in developing its satellite system, but critical decisions and milestones lie ahead," and "the program still faces significant risks." GAO noted that "there are also potential satellite data gaps in the DOD and European polar satellite programs, which provide supplementary information to NOAA forecasts."

Following the GAO report, NOAA's meteorological satellite programs drew fire from the NESDIS-chartered IRT, headed by former Lockheed Martin executive A. Thomas Young, from the office of the Dept. of Commerce inspector general (IG), and from a Satellite Task Force (SATTF) of outside analysts formed by the NOAA Science Advisory Board. The SATTF, for example, concluded that "NOAA's budget for currently planned space systems appears to be unsustainable."

The IRT called DOC/NOAA oversight of all Earth observing satellite programs "dysfunctional," but its report was not all negative. The review panel noted that "a competent, experienced [JPSS] program office has been established" and that "despite funding challenges, good progress has been made." It also praised the program office's management of the Suomi satellite, which is said to be doing a good job of delivering data for weather forecasting.

"The success of the NOAA satellite enterprise is critical to the United States," the IRT report declared. "The program contributes to the economy, national security, and to safety and quality of life," it said. The IRT panel also criticized NOAA's oversight and management of weather satellite programs, and noted that the JPSS-1 instrumentation may have to be cut back if the satellite is to be developed and produced in time to avoid a coverage gap. It recommended that the JPSS mission be simplified to focus on weather observation and ozone monitoring.

Recommended remedies

The IRT report suggested that NOAA consider replacing the VIIRS instrument on JPSS-1 if its development continues to engender cost increases and technical problems. The VIIRS on Suomi is said to be functioning pretty well, although four of its 22 channels reportedly have problems.

NOAA's ability to manage the development and acquisition of JPSS satellites was called into question by Commerce's IG as well. The IG report recommended, among other things, that NOAA devote more resources to refining performance requirements and defining systems for JPSS-1 and JPSS-2, permanently filling key management positions in the program, and making better estimates of costs and schedules.

The SATTF report recommended that NOAA consider adopting a "distributed systems architecture" for future Earth observing satellites that would feature single-purpose instruments on many smaller satellites instead of multipurpose instruments consolidated on larger and fewer satellites, the current approach.

CrIS provides input for numerical weather prediction models.

In response to the flurry of critiques, NOAA restructured the JPSS program in an attempt to streamline management, come more quickly to final decisions on the design of JPSS components, devise a realistic cost estimate, and expedite the development process.

Top priority

Meanwhile, the dreaded gap in Earth observational coverage draws nearer. A NOAA spokesperson said the agency is working on plans to mitigate any such gap and will reassess them twice a year to take into account new developments in satellite programs. "The administration is committed to providing the American public with life-and-property-saving forecasts and warnings," and this is NOAA's "top priority," the spokesperson declared.

The stakes are high. As a Raytheon paper points out, the importance of timely and accurate weather forecasting "cannot be overstated," and the lack of such forecasting also "would put our nation's economy at risk." ⩓