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Fact Sheet
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NOAA'S FY2019 BUDGET REQUEST FOR SATELLITES

Congress appropriated $1,454,731,000 for NOAA's satellite programs as part of the Consolidated Appropriations Act, 2019 (H. J. Res. 31, P.L. 116-6) after a grueling process that included a 35-day partial government shutdown from December 22, 2018 – January 25, 2019.

The appropriation is $55.168 million more than the request of **$1,399,563,000** for procurement, acquisition and construction (PAC) activities for NOAA's satellite programs, the only portion of the NOAA budget tracked in this report.

For FY2018, Congress had appropriated $1,857,249,000 for NOAA/NEDIS PAC activities. The sharp reduction from FY2018 to FY2019 is largely because two of NOAA's major satellites programs, JPSS and GOES-R, passed their funding peaks.

NOAA is part of the Department of Commerce and its funding is in the Commerce-Justice-Science (CJS) appropriations bill.

- The **House Appropriations Committee** approved its CJS bill on May 17, 2018. It provided **$1,412,263,000** for the PAC account, a small increase of $12.7 million.

- The **Senate Appropriations Committee** approved its version on June 14, 2018. The comparable Senate figure is $**1,498,092,000**, an increase of $98.5 million. (The Senate committee's report shows the total as $1,500,542,000**,** because it includes funding for a construction project that the request and the House committee account for separately).

Introduction

The National Oceanic and Atmospheric Administration (NOAA) manages the nation's civilian weather satellite and other operational environmental satellite programs. NOAA is part of the Department of Commerce and has a broad set of missions that include marine fisheries management, ocean and atmospheric research, and operation of the National Weather Service as well as its satellite programs.

NOAA's satellite programs are part of NOAA's National Environmental Satellite, Data and Information Service (NESDIS). The NESDIS budget is separated into two accounts:

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Operations, Research and Facilities (ORF) and Procurement, Acquisition and Construction (PAC). The PAC account contains funding for acquisition of new satellite systems *and is the only portion of the NESDIS budget tracked in this fact sheet*. NOAA's FY2019 budget request is available in its "Blue Book," posted on the NOAA website.

NOAA's Satellite Programs

Responsibilities for government weather, land imaging, and earth science satellites are split among several agencies. NOAA manages the nation's civilian weather satellites and, historically, other operational environmental satellite programs. NASA builds and launches earth science satellites for research and technology development purposes. The U.S. Geological Survey operates the government's Landsat land remote sensing satellites. The Department of Defense (DOD) has its own weather satellite program as well as classified satellites for intelligence gathering.

This fact sheet covers only NOAA's satellite programs and only the Procurement, Acquisition and Construction (PAC) account.

Weather Satellites

NOAA operates two complementary weather satellite systems, one in polar orbit and one in geostationary orbit.

Polar Orbit

Satellites in polar orbit circle Earth's poles, allowing them to view the entire planet. NOAA's polar orbit satellites have been referred to as POES – Polar Orbiting Environmental Satellites – for decades. Once a POES satellite is in orbit, it is given a designation of "NOAA" followed by a number.

The United States began launching polar orbiting weather satellites in 1960 under NASA's aegis. As the program matured from research and development (R&D) to operations, it was transferred to the Environmental Satellite Services Administration (ESSA), which later became NOAA. The first satellite to be designated NOAA was launched in 1983. The last in that POES series, NOAA-19, was launched in 2009.

In 1994, the Clinton-Gore Administration directed NOAA and DOD to merge their separate civil and military polar orbiting weather satellites programs. That became the National Polar-orbiting Operational Environmental Satellite System (NPOESS) program. NASA was part of NPOESS in a technology development role. In 2010, after 16 years of cost overruns and schedule delays, NPOESS was terminated and NOAA and DOD were directed to return to separate systems.

Meanwhile, in 2011 NASA launched the technology demonstration satellite it had been building for NPOESS, which is now designated Suomi-NPP.[1]

Following the termination of NPOESS, NOAA initiated the **Joint Polar Satellite System (JPSS)** program. When JPSS began, NOAA was criticized for its high cost -- $12.9 billion for four satellites (a total that included about $4 billion in sunk costs in NPOESS) plus ground systems.

NOAA reduced the cost from $12.9 billion to $11.3 billion simply by narrowing the definition of what is included in the estimate – only two satellites (JPSS-1 and JPSS-2) instead of four, plus the sunk costs in NPOESS and ground systems. The other two satellites (JPSS-3 and JPSS-4) were put into a separate line item -- **Polar Follow On (PFO)**.[2]

JPSS-1 was launched on November 18, 2017. Once in orbit it was redesignated NOAA-20. JPSS-2 is expected to be launched in 2021.

Polar Weather Satellites. In the FY2019 budget request**, JPSS and PFO were merged** into a single budget line item: Polar Weather Satellites. JPSS has been fully funded in recent years, but PFO struggled to win support in part because the satellites will not be launched for many years.

At the end of the Obama Administration, Congress appropriated $328.9 million for PFO in FY2017 and NOAA's FY2017 budget documentation showed the agency planned to request $586 million in FY2018. Instead, the Trump Administration's request for FY2018 was only $180 million and future years were listed as "TBD." NOAA stated in its FY2018 budget book that it would "initiate a re-plan" for the PFO program and "work to improve its constellation strategy considering all the polar satellite assets to ensure polar weather satellite continuity while seeking cost efficiencies, managing and balancing system technical risks and leveraging partnerships." Congress did not agree, however, and appropriated $419 million for PFO in FY2018, less than what had been projected, but substantially more than requested.

The FY2019 budget request reflected the Trump Administration's new plan. **It requested $878 million** for the new combined Polar Weather Satellites line item. According to NOAA's budget documentation, that represented a $230.7 million net decrease, but "maintains the original Launch Readiness Dates for JPSS-3 and JPSS-4."

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[1] Because of the many years that would elapse between the launch of NOAA-19 and JPSS-1, NOAA began using NASA's Suomi-NPP (S-NPP) as an operational weather satellite even though it is a technology demonstrator with a design life of only three years. NOAA officials and others repeatedly expressed concern that NOAA-19 and S-NPP might cease functioning before JPSS-1 was launched and a "gap" in weather satellite coverage might occur. However, that did not occur. NOAA-19, S-NPP and JPSS-1 (NOAA 20) are all currently operational.

[2] In prior years, NOAA included a request of $10 million for an Earth Observing Nanosatellite-Microwave (**EON-MW**) as part of the PFO budget. The EON-MW concept was to build and launch a very small ("nano") satellite carrying a single microwave instrument that could provide vital measurements in case something went awry with JPSS-1. Congress was lukewarm about the idea. In FY2016 it denied the request. In FY2017 it said EON-MW could proceed as long as it did not interfere with PFO and would have to be paid for within available funds. No mention has been made of EON-MW in subsequent budget requests.

The FY2019 money would support operation of Suomi-NPP and JPSS-1/NOAA-20; continued development of instruments for JPSS-2, -3 and -4; and continued development, operations, maintenance and sustainment of their ground systems.

Congressional Action. The House Appropriations Committee did not agree to merge the two accounts. It allocated the same total amount of money ($878 million), but split into $572 million for JPSS and $306 million for PFO. The committee did not explain its decision, but commended NOAA on the launch of JPSS-1 and "expects NOAA to incorporate lessons learned from JPSS-1 into the planning and execution of the remaining JPSS satellites." The committee went on to say that it supported procuring JPSS-3 and JPSS-4 in FY2019 and understands the KDP-C (Key Decision Point-C) milestone will be reached in FY2019 and expects to receive the program baseline also in FY2019.

The Senate Appropriations Committee did agree to merge the two accounts and added $50 million. However, it also **imposed a cap of $7.573 billion for PFO** and restated that the cap for JPSS is $11.322 million.

The final bill kept JPSS and PFO separate as the Senate recommended, but did not adopt the Senate position regarding caps. Report language said the committees would continue to consider merging the two accounts, but wanted more information on efficiencies that would be gained. JPSS was funded at $588,035,000 and PFO at $329,956,000, a total of $917,991,000 about $40 million higher than the request and the House committee recommendation.

COSMIC-2 GPS Radio Occultation (RO). NOAA is part of an international/interagency team building and operating a constellation of small satellites, COSMIC-2, to enhance the accuracy of forecasts using data from the polar orbiting satellites.

The Constellation Observing System for Meteorology, Ionosphere and Climate (COSMIC)-2 program is a constellation of 12 very small ("micro") satellites built by NOAA in cooperation with Taiwan and the U.S. Air Force. It is a follow on to COSMIC (also known as Formosat-3), a set of six microsatellites launched in 2006.

The satellites use signals from the Global Positioning Satellite (GPS) system for radio occultation (dubbed GPS-RO or GNSS-RO[3]) to make measurements of temperature and water vapor throughout the lower parts of the atmosphere. When combined with measurements from polar-orbiting weather satellites, better weather forecasts are enabled.

NOAA's goal is to have at least two sets of six microsatellites in low Earth orbit: one in equatorial orbit and the other in polar orbit. NOAA also funds the ground system for reception and processing of the COSMIC data.

[3] GPS is the U.S. satellite system for positioning, navigation and timing (PNT) data. Russia, China and Europe have their own systems (GLONASS, Beidou and Galileo). Collectively they are referred to as Global Navigation Satellite Systems (GNSS). The COSMIC-2 satellites can use any of the signals.

NOAA originally planned to fund the construction of the COSMIC-2 satellites, but private sector companies have emerged that want to provide RO data on a commercial basis using their own satellites. See prior year versions of this fact sheet information on the request and appropriations for COSMIC-2 and the debate over obtaining such data from commercial sources instead.

NOAA has stated that as many as 50,000-100,000 RO measurements per day would be useful and COSMIC provides only 2,000-3,000, so there is ample opportunity for other providers of such data if it meets NOAA's criteria that the data are accurate, reliable, timely, and can be validated.

The Trump FY2018 budget request was $6.1 million for COSMIC ground systems, but none for satellites. Congress agreed with the request

For FY2019, the COSMIC-2 request was $5.9 million.

Congressional Action. The House and Senate Appropriations Committees each approved the requested amount and that is what was included in the final appropriation.

The Senate committee, however, expressed concern in its report about a potential gap in RO data if the commercial sector does not provide it through the Commercial Weather Data Pilot program discussed below. While saying it is "optimistic" about the commercial effort, it adds that "[w]ith NOAA's cancellation of COSMIC 2B and the original COSMIC program nearing the end of its life, the Committee directs NOAA to develop and submit a plan within 180 days of passage [of the bill] to manage the risk of an RO gap and preserve the quality of NOAA forecasts."

Geostationary Orbit

NOAA's other weather satellite system is in geostationary orbit 35,800 kilometers (22,300 miles) above the equator where satellites maintain a fixed position relative to a point on Earth. Such weather satellites are especially useful for monitoring tropical regions where hurricanes form.

NOAA keeps one Geostationary Operational Environmental Satellite (GOES) over the eastern region of the United States and adjacent waters and another over the western region. Whatever satellites are in those positions are designated "GOES-East" and "GOES-West." NOAA typically also keeps a spare satellite in between those two positions that can be moved quickly to replace a malfunctioning satellite if necessary (as happened in 2012 and 2013).

NOAA is procuring[4] four new significantly enhanced GOES satellites – a block buy called the GOES-R series. Initially given letter designations (GOES-R, -S, -T and –U), they are changed to numbers once they are in orbit.

[4] NASA serves as the procurement agent for NOAA's satellites. NOAA specifies the requirements and provides the funding while NASA contracts for construction and launch of the satellites.

The GOES-R satellite itself was successfully launched in November 2016 and is now GOES-16 and in the GOES-East position, replacing GOES-13, which has been decommissioned.

The series is still colloquially referred to as "GOES-R." The next one, GOES-S, was successfully launched on March 1, 2018 and is now GOES-17, but it is experiencing technical difficulties. Nevertheless, NOAA declared it operational and it is now in the GOES-West position.

The FY2018 budget request for the GOES-R series was $519 million, a steep drop from the $753 million appropriated for FY2017, but that is a planned reduction as development ramps down. Congress agreed with the request.

The request for FY2019 is $408 million.

Congressional Action. The House and Senate Appropriations Committees approved the requested amount and that is in the final appropriations bill.

Space Weather Satellites

Space weather is a term used to refer to ejections from the Sun – Coronal Mass Ejections (CMEs) and solar wind – that can overload systems on Earth and in orbit that are crucial to daily life, such as the electric grid or communications and navigation satellites.

NOAA operates the Space Weather Prediction Center in Boulder, CO that relies on data from many sources, including spacecraft located 1.5 million kilometers (1 million miles) from Earth at the Sun-Earth L1 Lagrange point.

The primary spacecraft for observing CMEs is Europe's Solar Heliospheric Observatory (SOHO), which is quite old. It was launched in 1995. It has a coronagraph that blocks the light from the Sun so it can observe the Sun's corona and detect CMEs. NASA's Advanced Composition Explorer (ACE) and the NOAA/NASA/Air Force Deep Space Climate Observatory (DSCOVR) detect solar wind. ACE also is quite old, having been launched in 1997. DSCOVR was launched on February 11, 2015. It is now operational and funded through NOAA's Operations, Research and Facilities (ORF) account, which is not tracked in this fact sheet.[5]

The question now is what spacecraft and instruments are needed to enable space weather predictions in the future. Congressional interest in space weather is growing. On May 2, 2017, the Senate passed the Space Weather Research and Forecasting Act (S. 141) to focus attention on the issue, although its focus is agency roles and responsibilities, not funding. The House Science, Space, and Technology Committee held a hearing on its version of the bill (H.R. 3806) on April 26, 2018. No legislation cleared the 115th Congress, however.

NOAA requested small amounts of money in FY2016 and FY2017 to begin analyzing alternatives for a successor to DSCOVR. In its FY2017 request, NOAA outlined a robust plan to

[5] DSCOVR has two NASA instruments that the Trump Administration wants to turn off. They are discussed in our companion fact sheet on NASA's budget request.

acquire two new satellites, two sets of sensors, and two launches, with the goal of launching the first of the two satellites in FY2022 before the end of DSCOVR's design lifetime.

The FY2017 request was $2.5 million and Congress doubled it to $5 million. The projected request for FY2018 was $53.7 million, ramping up to $186.1 million in FY2019, $154.5 million in FY2020, and then down to $81.5 million in FY2021.

The Trump FY2018 budget request did not support that plan, however. The request for Space Weather Follow-on was only $500,000. The request also included $4.9 million for System Architecture and Advanced Planning (SAAP) to complete the NOAA Satellite Observing System Acquisition (NSOSA) study and associated grant work that included assessing future satellites for weather, space weather and environmental remote sensing beyond 2028.

Congress did not agree and appropriated $8.545 million for the Space Weather Follow-On and directed NOAA to provide "a full assessment of launch options for a coronagraph, and a plan to address non-coronagraph space weather requirements" within 180 days of enactment. Further, it directed NOAA to coordinate with DOD and NASA "to ensure NOAA is providing cost-effective operational space weather assets and NASA is providing technology development, in accordance with the National Space Weather Action Plan."

That action took place after the Trump Administration had submitted its FY2019 request, which laid out its new plan. It focused on a replacement for SOHO's coronagraph rather than a successor to DSCOVR**.** Modestly funded at $10 million per year FY2019-2023, the Trump Administration's Space Weather Follow-on would fund the Naval Research Laboratory (NRL) to build a Compact Coronagraph (CCOR) to image CMEs. CCOR would not be launched on its own spacecraft, but integrated into the GOES-U geostationary weather satellite's suite of instruments and launched in 2024.

Congressional Action. The House Appropriations Committee approved the requested amount ($10 million).

The Senate Appropriations Committee added $2 million, for a total of $12 million. It stated that the extra $2 million is for NOAA to pursue launch options for the compact coronagraph (the CCOR). It said that the government needs a "coherent space weather architecture that addresses scientific, national security and meteorologically operational requirements using a constellation of lower cost satellites" similar to those that NASA launches in its Explorer-class of missions and "expects to receive a plan before the end of fiscal year 2018."

In the final appropriations bill, Congress provided $27 million, almost triple the request, and directed that a second CCOR be built and added to the instrument suite on the Interstellar Mapping and Acceleration Program (IMAP) spacecraft that will be launched to the Sun-Earth L1 Lagrange point.

Cooperative Data and Rescue Services (CDARS, formerly SIDAR)

In FY2015 and FY2016, NOAA requested funds for a Solar Irradiance, Data and Rescue (SIDAR) program to replace the Polar Free Flyer (PFF) in NOAA's FY2014 budget request, which was zeroed by Congress. The goal was to find a way to launch three instruments – Total Solar Irradiance Sensor (TSIS), Advanced Data Collection System (A-DCS), and Search and Rescue Satellite-Aided Tracking (SARSAT) – that were intended to be launched on the cancelled NPOESS satellites (explained earlier). The JPSS spacecraft that replaced NPOESS are too small to accommodate these instruments.

SIDAR was not popular in Congress and the TSIS sensor ultimately was transferred to NASA. By FY2016, what remained in this line item was funding for A-DCS and SARSAT.

For FY2017, the account's name was changed to CDARS, although the House Appropriations Committee still referred to it as SIDAR. The FY2017 request was $500,000 and Congress appropriated that amount.

The Trump FY2018 budget request was $500,000. Without explanation, Congress significantly increased that amount to $21,650,000.

For FY2019, the request is $500,000.

Congressional Action. The House Appropriations Committee approved the requested amount.

Like last year, the Senate provided a significant increase in funding for this program -- $37.9 million, which is $37.4 million above the request. No explanation for the increase was provided.

The final appropriation provides $26.5 million, again with no explanation.

Commercial Weather Data Pilot

Congress directed NOAA to initiate a commercial weather data pilot program in the FY2016 appropriations act to determine if weather data from commercial companies can be utilized in NOAA's weather models. Language in the accompanying explanatory report directed NOAA to seek to enter into at least one pilot contract, through a competitive process, to assess the potential viability of commercial weather data in its weather modeling and forecasting. NOAA officials expressed concern about whether commercial data will be accurate, reliable, timely, and can be validated. The pilot program is intended to answer those questions.

NOAA was required to submit an implementation plan for the pilot program. It provided the report to Congress in March 2016 and made it public in April. The pilot program will focus on radio occultation (RO) data, discussed earlier.

NOAA selected two companies, Spire Global and GeoOptics, to participate in the pilot program. Both will use constellations of very small satellites with comparatively short lifetimes that are

launched in groups. The GeoOptics system is Cicero. The first four satellites were launched on a Russian Soyuz rocket in 2017, but three of the four failed apparently because of a problem with the rocket's Fregat upper stage. Another one was successfully launched on a different rocket in 2018 (Rocket Lab's Electron from New Zealand). Dozens of Spire's Lemur satellites have been launched.

As noted earlier, the FY2018 Trump budget request supported acquisition of data from commercial sources, but requested only $3 million, a reduction from the $5 million appropriated for FY2017. (See prior year versions of this fact sheet for funding in FY2016.) Congress did not agree and doubled the appropriation to $6 million.

The FY2019 request is $3 million. Acting NOAA Administrator RDML Timothy Gallaudet (Ret.) was asked about the program during an April 11, 2018 hearing before the Commerce-Justice-Science Subcommittee of the House Appropriations Committee. He said the effort to procure commercial data was moving more slowly than anticipated because at that time only one company was currently able to offer it. That is Spire. As noted, GeoOptics was still waiting to get an operational satellite into orbit.

NOAA awarded a second round of contracts in September 2018 to three companies: Spire, GeoOptics and PlanetIQ.

Congressional Action. The House Appropriations Committee doubled the amount requested, matching the appropriated amount for FY2018 -- $6 million. It said it wanted to "ensure NOAA has the resources necessary to thoroughly assess commercial data opportunities."

The Senate Appropriations Committee approved the requested amount. As explained earlier under COSMIC, the committee expressed optimism about this effort, but also concern that a gap in RO data could occur if the commercial sector is not, in fact, able to provide the data.

The final appropriations bill adopted the House position and allocated $6 million.

Other NESDIS Satellite-Related Activities

The PAC account in NESDIS also funds satellite ground services; systems architecture and advanced planning; and projects, planning and analysis (PPA).

"Satellite CDA" is sometimes listed as part of the NESDIC PAC account. It is a construction project and therefore not tracked in this fact sheet or included in the following table since neither NOAA nor the House Appropriations Committee include in theirs. Only the Senate Appropriations Committee does (see footnote 2 to the table 2).

NOAA's FY2019 Budget Request for Satellite System Acquisition (in $ thousands; see notes on next page)

Program	FY2017 enacted	FY2018 enacted	FY2019 Appropriations			
			Request	House Committee	Senate Committee	Final
GOES-R	752,784	518,532	408,380	408,380	408,380	408,380
Jason-3	4,357	Note 3	Note 3	Note 3	Note 3	Note 3
JPSS	787,246	775,777	N/A	572,240	N/A	548,035
Polar Follow On (PFO)	328,900	419,000	N/A	305,751	N/A	329,956
Polar Weather Satellites (merger of JPSS and PFO)	N/A	N/A	877,991	N/A	927,991	N/A
Coop Data/Rescue Services (CDARS)	500	21,650	500	500	37,900	26,539
DSCOVR	3,745	Note 3	Note 3	Note 3	Note 3	Note 3
Space Wx FO	5,000	8,545	10,000	10,000	12,000	27,000
COSMIC-2 (ground system) (new sats/data)	8,100 (8,100) (0)	6,100	5,892	5,892	5,892	5,892
Satellite Grnd Services	54,000	57,325	52,332	58,000	58,000	58,000
Sys Architecture & Adv Planning	3,929	4,929	4,929	5,500	4,929	4,929
Projects, Planning & Analysis	25,200	39,391	36,539	40,000	40,000	40,000
Commercial Weather Data Pilot	5,000	6,000	3,000	6,000	3,000	6,000
TOTAL	1,978,761	1,857,249	1,399,563	1,412,263	Note 2 1,498,092	1,474,731

Source: FY2017 enacted and FY2019 request—Department of Commerce budget documents. FY2018 enacted—explanatory statement to accompany FY2018 Consolidated Appropriations Act, H.R. 1625, Division B. FY2019 House, Senate, and Final from committee reports on the FY2019 Commerce-Justice-Science appropriations bill and the Consolidated Appropriations Bill, 2019.
Note 1: Text and numbers in parentheses are subsets. NA = not applicable.
Note 2: This fact sheet does not track spending for the other NESDIS budget account, Operations, Research and Facilities (ORF), so the totals shown here may not conform to other sources. The Senate Appropriations Committee report usually includes another line – "satellite CDA facility" – that is not tracked in this fact sheet because it is a construction project, not a satellite system. The request and the House Appropriations Committee report separate the satellite CDA facility from the other spending. The Senate committee does not and provided $2,450,000 for it. Thus, the Senate report shows the total as $1,500,542,000.
Note 3: Beginning with the FY2018 budget request, Jason-3 and DSCOVR are funded in the ORF account, which is not tracked in this fact sheet.