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NASA'S FY2018 BUDGET REQUEST

President Trump released his complete FY2018 budget request on May 23, 2017. The total request for NASA is $19,092.2 million, a reduction of $561.1 million from the $19,653.3 million appropriated by Congress for FY2017.

The House and Senate Appropriations Committees have approved their versions of the FY2018 Commerce-Justice-Science (CJS) bill, which includes NASA.

- The House committee approved $19.872 billion, an increase of $780 million above the Trump request and $218 million more than FY2017.
- The Senate Appropriations Committee approved $19.529 billion, $437 million more than the request, but $124 million less than FY2017.

Trump Administration's FY2018 Budget Request

Compared with many other non-defense federal agencies, NASA fared well in President Trump's FY2018 budget request. When the FY2018 budget was formulated in the spring of 2017, NASA was operating under a Continuing Resolution at its FY2016 funding level of $19.265 billion. The Trump Administration issued a "budget blueprint" or "skinny budget" on March 16, 2017 revealing its FY2018 request for NASA as $19.1 billion, a reduction of just 0.8 percent. Much deeper cuts were proposed for agencies such as the National Institutes of Health, National Science Foundation, and Environmental Protection Agency.

In May, Congress finally completed action on the FY2017 funding bills, however, and appropriated more for FY2017 – $19.653 billion. Thus, the Trump request turned out to be a 2.8 percent cut from FY2017.

The budget blueprint outlined plans for NASA and other agencies in the discretionary portion of the federal budget while the Administration continued to formulate its complete budget request. The complete request was released on May 23 and supersedes the blueprint, but some of the points in the blueprint remain relevant, including the following. The budget request –

- "Supports and expands public-private partnerships as the foundation of future U.S. civilian space efforts."
- "Paves the way for eventual over-land commercial supersonic flights and safer, more efficient air travel" providing $624 million for aeronautics.
- Provides $1.9 billion for robotic planetary exploration, including Europa Clipper and Mars 2020. It specifically states that no funding for a Europa lander is included.

By Marcia S. Smith

- Provides $3.7 billion for the Space Launch System/Orion/exploration ground systems program.
- Cancels the Asteroid Redirect Mission.
- Provides $1.8 billion for earth science, $102 million less than the annualized level in the FY2017 Continuing Resolution, terminating four missions: PACE, OCO-3, DSCOVR earth-viewing instruments, and CLARREO Pathfinder. Reduces funds for Earth science research grants.
- Eliminates NASA's Office of Education.
- Restructures the RESTORE-L satellite servicing mission to reduce cost and "better position it to support a nascent commercial satellite servicing industry."
- Strengthens NASA's cybersecurity capabilities.

The May 23 complete budget request aligns with the blueprint, although an additional Earth science mission (the Radiation Budget Instrument) is proposed for termination.

The May 23 budget request also revealed the "out-year" projections for NASA's budget through FY2022. It is absolutely flat, with no adjustment even for inflation. Acting NASA Administrator Robert Lightfoot said in testimony to the Senate Appropriations CJS subcommittee on June 29, 2017 that a flat budget translates into a reduction of $4.5 billion in buying power over that period of time.

Key Issues

The earth science budget cuts, the lack of funding for a Europa lander, the elimination of NASA's Office of Education, and the proposal to restructure the RESTORE-L satellite servicing technology development and demonstration mission are key issues as Congress deliberates on the budget request.

However, many NASA supporters in Congress and the space community are eager to move forward with human exploration beyond low Earth orbit and were hoping the Trump Administration would say something about restoring human missions to the surface of the Moon to NASA's plan. That has not happened. In fact, the budget request for the Space Launch System (SLS) and Orion crew spacecraft – already in development for missions beyond low Earth Orbit – is status quo. It does not support acceleration or expansion of NASA's human spaceflight plan or include specific funding for the "Deep Space Gateway" NASA officials have been promoting over the past several months as the replacement for the Asteroid Redirect Mission (ARM) as the next steppingstone to human fights to Mars.

Congress increased NASA's budget significantly in FY2017 compared to President Obama's request (see our FY2017 NASA budget fact sheet) and it would not be surprising to see an effort to achieve a similar outcome for FY2018.

Earth Science

Trump Proposal. The Trump Administration is proposing deep cuts to climate change research across the government and NASA's earth science program was expected to be significantly

impacted. However, it was reduced less than many feared. For FY2017, earth science received $1,921 million; the FY2018 request is $1,754 million, a reduction of $167 million.[1]

The cut would terminate five NASA earth science missions – PACE, RBI, CLARREO-Pathfinder, OCO-3, and DSCOVR Earth-facing instruments. The last three involve relatively small amounts of money. (Budget numbers below for FY2017 and projected for FY2018 and beyond are from NASA's FY2017 budget book, which included projected budgets through FY2021).

- **PACE,** the Plankton, Aerosol, Clouds and Ocean Ecosystem spacecraft, is the most expensive of the five. PACE will provide high quality global observations about ocean health and its relationship to airborne particles and clouds. Among other things, the data would be used for fisheries management and responding to harmful algae blooms. (Phytoplankton, also called microalgae, are microscopic marine plants that live suspended in water. Fish and other marine life feed on them, but if too many nutrients are available in the water they can grow out of control – bloom – and produce toxic compounds.)

  The FY2017 request was $89 million. The projected requests were $78.9 million (FY2018), $144.4 million (FY2019), $196.0 million (FY2020) and $137.1 million (FY2021), so a total of $556.3 million would be saved in those four fiscal years. The mission is cost-capped at $805 million including launch, operations, and science investigations. Launch is currently scheduled for 2022-2023. PACE is being built and tested at NASA's Goddard Space Flight Center in Greenbelt, MD.

- The **Radiation Budget Instrument (RBI)** is a scanning radiometer that would measure the Earth's reflected sunlight and emitted thermal radiation, continuing measurements made by CERES (Clouds and Earth's Radiant Energy Systems) instruments since 1998. The data would be used as input for extended range (10-day or more) weather forecasts. RBI is designed to fly on one of NOAA's polar-orbiting weather satellites – Joint Polar Satellite System-2 or JPSS-2. (A CERES instrument will be aboard JPSS-1, which is scheduled for launch in September 2017.) The proposal to terminate RBI was attributed to cost growth and technical challenges. Harris Corporation is building RBI under a contract managed by NASA's Langley Research Center in Hampton, VA.

  The FY2017 request was $54.3 million. The projected requests were $46 million (FY2018), $17.2 million (FY2019), $9.4 million (FY2020), and $6.8 million (FY2021). The savings for FY2018-2021 would be $79.4 million assuming no termination costs.

- **CLARREO Pathfinder and OCO-3** are instruments that would be attached to the International Space Station (ISS) so are comparatively inexpensive since they are not free-flying satellites.

[1] The March 16 budget blueprint said the reduction was $108 million, leaving $1.8 billion. At that time, NASA was funded by a Continuing Resolution at its FY2016 funding level and those figures were correct. The Trump Administration subsequently decided to cancel a fifth earth science mission – RBI – so the figures in the May 23 budget documents do not match those in the March 16 blueprint.

CLARREO is the Climate Absolute Radiance and Refractivity Observatory, a mission that was recommended by the 2007 Earth Science and Applications from Space Decadal Survey produced by the National Academies of Sciences, Engineering, and Medicine. In 2016, a decision was made to focus first on a technology demonstration mission – CLARREO Pathfinder – to attach a Reflected Solar Spectrometer to the ISS around 2020. The FY2017 request for CLARREO Pathfinder was $19 million. The budget projection was for it to grow to $28 million in FY2018, then ramp down to $15.4 million in FY2019, $2.1 million in FY2020 and $0.2 million in FY2021. Thus the total savings (assuming no termination costs) for FY2018-2021 would be $45.6 million. CLARREO Pathfinder is managed by NASA's Langley Research Center in Hampton, VA.

OCO is the Orbiting Carbon Observatory. The first OCO was lost in a launch failure. A replacement, OCO-2, was launched in 2014. OCO-3 would use spare parts from OCO-2 to build an instrument to be attached to the ISS. According to NASA, the purpose is to study the distribution of carbon dioxide on Earth as it relates to urban populations and changing patterns of fossil fuel combustion. The FY2017 request was $26.3 million. The projection was for that amount to decline to $9.5 million in FY2018 and $4.2 million in FY2019, then rise to $6.6 million in FY2020 and $6.8 million in FY2021. Termination (assuming no termination costs) would save $27.1 million in FY2018-2021. OCO-3 is a project of the Jet Propulsion Laboratory (JPL) in Pasadena, CA.

- **DSCOVR, the Deep Space Climate Observatory,** was launched in 2015. Its primary mission today is to provide space weather data and is funded by NOAA, not NASA. However, NASA designed and built two of the four instruments on DSCOVR: the Earth-Polychromatic Imaging Camera (EPIC) that constantly provides full-disk views of Earth from the spacecraft's vantage point 1.5 million kilometers away, and the National Institute of Standards and Technology Advanced Radiometer (NISTAR).

  The Trump budget request proposes eliminating funding for these two "earth-facing" (as opposed to Sun-facing) instruments. In the NASA budget, DSCOVR is funded at $1.7 million in FY2017. The projection is for that to decline to $1.2 million in both FY2018 and FY2019, $0.8 million in FY2020, and zero in FY2021. That represents a total savings (assuming no termination costs) of $3.2 million from FY2018-2021. NASA's money is used for analysis and processing of the data from the two NASA-provided instruments.

  DSCOVR originated in the Clinton Administration where it was championed by Vice President Al Gore. His goal was to have a satellite that provided a constant view of Earth to help remind everyone of the fragility of the planet and its climate. He named the spacecraft Triana, but it was harshly criticized by Republicans in Congress and dubbed "Goresat." After a review by the National Academy of Sciences, science instruments were added to make it more scientifically valuable, but President George W. Bush suspended the program when he took office. The satellite remained in storage throughout most of the Bush term, but was resurrected, renamed, and launched during the Obama Administration. Today it is operated by NOAA since its primary role is providing space weather data, a NOAA responsibility.

Budget savings do not appear to be the driving force for proposing these terminations. Instead, it apparently is based on Trump Administration skepticism about climate change. In releasing the budget blueprint on March 16, White House Office of Management and Budget (OMB) Director Mick Mulvaney said of climate change research: "We're not spending money on that anymore. We consider that to be a waste of your money to go out and do that." The Trump budget proposal cancels or sharply reduces funding for climate change initiatives across the government.

Many congressional critics of NASA's earth science program are climate change skeptics, but the argument is rarely couched in those terms. Instead, the line of reasoning is that other federal agencies study the Earth, but only NASA sends probes to other places in the solar system, launches telescopes into space, or supports human exploration of space. They argue those are NASA's core missions, not earth science. Supporters of NASA's earth science program note that the 1958 National Aeronautics and Space Act that created NASA lists "expansion of human knowledge of phenomena in the atmosphere and space" first among the agency's objectives.

Congressional Action. Three of NASA's four oversight and funding committees have held hearings on the budget request so far: the House Science, Space, and Technology Committee, and the House and Senate Appropriations Commerce-Justice-Science (CJS) subcommittees. Democrats on all of those committees questioned the cuts to earth science.

However, the House Appropriations Committee approved an additional $50 million cut on top of the Trump-proposed reduction. The committee's report on the bill did not explain the reduction. Instead, the report specified that the Landsat-9 program be funded at $175.8 million to ensure launch in 2020, and expresses support for NASA's Earth Science Pathfinder Ventures program to provide flight opportunities for low cost missions that can be flown in 5 years or less. It approved the requested $199.1 million for that program.

By contrast, the Senate Appropriations Committee restored the $167 million cut in the Administration's proposal and specified the following amounts for four of the five programs proposed for termination: PACE, $147 million; CLARREO-Pathfinder, $28 million; OCO-3, $9.5 million; and DSCOVR instruments, $1.9 million. As for RBI, the committee required NASA to submit a report on the cost and schedule challenges facing it and what would be needed for it to be ready in time for its proposed launch. If the answer is favorable, NASA would be allowed to continue the RBI program within available funds. The Senate committee also fully supported the Landsat-9 program, providing more than the House – $198 million.

Planetary Science: A Mission to Europa

Trump Proposal. Congress is a strong supporter of NASA's planetary science program on a bipartisan basis. Attempts by the Obama Administration to cut funding for planetary science in recent years were firmly rejected. The Trump budget request provides a substantial boost compared to President Obama's request for FY2017 (from $1.39 billion to $1.93 billion), but is only slightly more than what Congress ultimately appropriated for FY2017 ($1.85 billion).

One planetary science program – robotic exploration of Jupiter's moon Europa -- has particularly enthusiastic support from Rep. John Culberson (R-TX), who chairs the House appropriations Commerce-Justice-Science (CJS) subcommittee that funds NASA. Europa has an ocean under its icy crust and some scientists believe conditions there might be suitable for microbial life to

develop. Culberson has said in many venues that he believes there is life in Europa's ocean and he is intent on funding spacecraft to find it.

Culberson already has added substantial amounts to NASA's budget to initiate a Europa mission even though NASA had no plans to do so. NASA generally follows the recommendations of the Decadal Surveys written by scientific experts under the aegis of the National Academy of Sciences, Engineering and Medicine. The most recent Decadal Survey for planetary science identified a series of missions aimed at returning a sample of Mars to Earth as its top priority for a large "flagship" program. A mission to Europa was listed second, primarily because of its high cost. The report left open the possibility that a lower cost Europa mission would be a higher priority if more funding than expected became available.

Project managers at the Jet Propulsion Laboratory (JPL) reformulated the mission to lower the cost and Culberson added the money. The mission, Europa Clipper, involves a spacecraft that will orbit Jupiter and make multiple flybys of Europa, some of them close to the surface. Fissures in Europa's icy surface allow material from the ocean to spew out and some scientists believe plumes rise above the surface to an altitude the spacecraft could reach.

Culberson put language in the FY2017 Consolidated Appropriations Act (P.L. 115-31) that Europa Clipper is to be launched in 2022 using NASA's new big rocket, the Space Launch System (SLS), which is currently under development. Acting NASA Chief Financial Officer Andrew Hunter said during a media briefing on May 23, 2017 that the FY2018 request for Europa Clipper – $425 million – is not sufficient to meet the 2022 launch date and it is a "challenge" to fulfill the requirements in the law. He added that NASA has informed Congress of how much money would be needed to meet that launch date. NASA's FY2018 budget book says that the requested funding level supports a launch date in the mid-to-late 2020s.

Culberson also wants NASA to build a second spacecraft that could land on the surface and specified in law that it be launched by 2024 also on SLS. NASA is formulating a concept for that lander in accordance with the law, but the FY2018 budget specifically does not include funding for it. NASA's budget book says no funding is provided to "send another flagship mission to Europa before analysis of the Europa Clipper data is completed."

This is certain to provoke debate because of Culberson's determination and influential position as chairman of the House Appropriations subcommittee that funds NASA. If he presses ahead with the requirement that Europa Clipper be launched by 2022 and a lander by 2024, the question will be whether he adds money to the budget or requires NASA to find the funds from within its other programs.

Congressional Action. During his June 8, 2017 hearing on the NASA budget request, Culberson expressed strong support for the orbiter and lander and pointed out that by law they both must be built. The House Appropriations Committee specified $495 million in FY2018 for the "Jupiter Europa Clipper and Lander missions" and directed NASA to submit budget requests in the future that support launch by 2022 and 2024 pending final mission configuration. The committee's report also cautions that it expects the program to meet development milestones on time and within budget. Overall, the House committee increased NASA's planetary science budget by $191.4 million over the request, raising it from $1,929.5 million to $2,120.9 million.

The Senate Appropriations Committee cut the planetary science budget by $317.6 million compared to the request. The committee's report made no mention of Europa Clipper or the lander. It has become commonplace for the Senate committee to provide more money for earth science and less for planetary science, and the House to do the reverse. They work out an acceptable compromise in conference.

Education

Trump Proposal. NASA funds education activities both through its Office of Education and as part of science missions in the Science Mission Directorate (SMD). Generally speaking, these efforts are part of an effort to encourage students to study Science, Technology, Engineering and Math (STEM) fields, which has been supported on a bipartisan basis in the White House and Congress for many years.

The Trump budget request, however, eliminates NASA's Office of Education, funded at $100 million in FY2017. The FY2018 request includes $37 million, but that is for close out activities only. The March Trump budget blueprint asserted that the Office of Education "has experienced significant challenges in implementing a NASA-wide education strategy and is performing functions that are duplicative of other parts of the agency."

The criticism may come as a surprise to many in Congress and the science community. Efforts in the Obama Administration to streamline STEM education programs across the government were firmly rejected by Congress on a bipartisan basis. During that period, NASA's education programs were reassessed and reconfigured to better differentiate between Office of Education and SMD activities.

Programs within NASA's Office of Education are very popular in Congress, which routinely adds money to the amounts requested by whatever Administration is in power. Three programs of special interest to many Members of Congress are the following:

- National Space Grant and Fellowship Program, a national network of 850 affiliates in colleges, universities, industry, museums, science centers, and state and local agencies in all 50 states plus the District of Columbia and Puerto Rico that fund fellowships and scholarships for students in STEM fields.
- Experimental Program to Stimulate Competitive Research (EPSCoR) that provides seed funding to enable 27 jurisdictions (24 states plus Guam, Puerto Rico and the U.S. Virgin Islands) to develop academic research enterprises directed toward long-term, self-sustaining, nationally-competitive capabilities in aerospace and aerospace-related research.
- Minority University Research and Education Program (MUREP) that enhances the capabilities of Historically Black Colleges and Universities (HBCUs), Hispanic Serving Institutions (HSIs), and Tribal Colleges and Universities (TCUs) through grants with the goal of recruiting underrepresented and underserved students into STEM fields through completion of undergraduate or graduate degrees.

The Office of Education also funds the STEM Education and Accountability Project (SEAP).

During the May 23, 2017 budget briefing, NASA Acting CFO Hunter specifically stated that the $37 million requested for FY2018 does not fund any of those programs. He added that NASA anticipates Congress will add money for them and the agency is still determining how it would manage those programs absent the Office of Education.

Congressional Action. Three of NASA's four oversight and funding committees have held hearings on the budget request so far: the House Science, Space, and Technology Committee, and the House and Senate Appropriations Commerce-Justice-Science subcommittees. Republicans and Democrats on all of those committees questioned the cuts to education.

The House Appropriations Committee approved $90 million for education: $18 million for EPSCoR, $40 million for Space Grant, and $32 million for MUREP. It did not refer to the proposal to eliminate the Office of Education, saying instead that it understands that office is "undergoing a series of internal reviews and assessments." It directs NASA to brief the committee when they are complete, but also to implement the three programs.

The Senate Appropriations Committee approved $100 million, divided the same as the House Committee, but with another $10 million for SEAP. It took no position whether the Office of Education should be eliminated, but directed NASA to use FY2018 to review how best to manage its education programs.

Human Spaceflight: SLS, Orion, and Deep Space Gateway

As explained in previous editions of these NASA budget fact sheets, NASA continues to try to define its future human spaceflight program. Today it is centered on utilization of the International Space Station (ISS), but that is seen as just the first step towards eventual human trips to Mars. While there is broad consensus that human exploration of Mars is the "horizon goal," there is less agreement on the steps to getting there.

President George W. Bush set the country on the path to returning humans to the Moon by 2020 as a step towards Mars, but President Obama cancelled that program (Constellation) and replaced it with the Asteroid Redirect Mission (ARM). Obama's decision sparked intense congressional backlash from both Democrats and Republicans. In the end, Congress passed the 2010 NASA Authorization Act that directed NASA to build a big new rocket, the Space Launch System (SLS), and a crew spacecraft (Orion), with the goal of eventually sending people to Mars while allowing ARM to proceed.

ARM has been explained in previous editions of these NASA budget fact sheets. In brief, President Obama wanted to send astronauts to an asteroid by 2025 instead of returning to the lunar surface as the next step to Mars. Over time, ARM evolved into a program where a robotic probe would be sent to an asteroid to pick up a boulder from its surface and move the boulder into lunar orbit where it would be visited by astronauts in an Orion spacecraft. The Trump budget request proposed terminating ARM. It had never gained popularity in Congress and the proposal generated no opposition. It already has been terminated by NASA as a program, but two aspects that have wide support – finding and tracking asteroids and developing high power solar electric propulsion (SEP) – will continue.

Trump Proposal. Since the beginning of the Trump Administration, NASA human spaceflight officials have shifted focus from ARM to what they call a Deep Space Gateway (DSG) to be built in lunar orbit instead. It would now become the next steppingstone to Mars using the Space Launch System (SLS) and Orion crew spacecraft already in development.

The DSG is still conceptual, but NASA describes it as a facility that could be used to support human missions to the lunar surface by international or commercial partners (NASA itself still has no plans to return humans to the lunar surface) as well as a "gateway" where crews would get ready to board Deep Space Transports to travel to Mars. NASA officials stress it would NOT be another space station like the International Space Station. It would be much smaller and not permanently occupied. The high power SEP systems that were being developed for ARM would be a major element of the DSG, allowing it to maneuver into different orbits about the Moon depending on requirements.

The FY2018 budget request, however, does not include funding for the DSG. NASA Acting CFO Andrew Hunter said at the May 23 budget briefing that NASA was "somewhat inhibited" in proceeding with it because of the flat budgets with no inflation adjustment in the future. He is hopeful that NASA will be successful in convincing the Trump Administration and Congress to support the DSG in the future. The request also reduces funding for SLS and Orion below their FY2017 levels (see Table 1).

Perhaps ironically, President Trump said recently that he wants to get people to Mars "sooner rather than later" and even suggested that it happen while he is President. The budget request certainly does not support such a goal.

Congressional Action. The House Appropriations Committee approved increases for Orion and SLS above the request, restoring them to their FY2017 funding levels ($1.35 billion and $2.15 billion respectively). It also increased funding for their associated Exploration Ground Systems (EGS) above the request, approving $600 million instead of the $460 million requested. It specified that $300 million of the SLS funding is for development of the Exploration Upper Stage (EUS). However, the committee expressed concern about schedule slips -- the first SLS launch with an uncrewed Orion recently slipped again, from November 2018 to sometime in 2019 (NASA has not set a new date) – and cost growth.

As for the Deep Space Gateway, the House committee directed NASA to submit a report with the estimated yearly costs of launching SLS with Orion or other science payloads "as envisioned in the deep space gateway concept." It also required NASA to fund development of nuclear thermal propulsion technology and directed NASA to report on how that propulsion could fit into the DSG concept.

The Senate Appropriations Committee approved the same increases for Orion and SLS above the request, including the set-aside for EUS. It specified $545 million for EGS, less than the House committee's recommendation, but noted there is an additional $95.9 million for Exploration-related construction of facilities in the CECR budget. The Senate committee's report does not mention the DSG.

RESTORE-L and Satellite Servicing

Trump Proposal. The Trump request would restructure NASA's RESTORE-L satellite servicing program. NASA has been planning not only to develop technology to refuel satellites in low Earth orbit, but to demonstrate the technology by launching a spacecraft in 2020 to refuel the Landsat-7 satellite.

The Defense Advanced Research Projects Agency (DARPA) separately has been developing technology to service satellites in geosynchronous orbits – the Robotic Servicing of Geosynchronous Satellites (RSGS) program.

The Trump Administration is proposing to limit NASA's role to technology development only, not demonstrating it by refueling Landsat 7. It also seeks to merge the NASA and DARPA efforts. The argument is that satellite servicing should be developed by the commercial sector and sold as a service to government and commercial customers, therefore the appropriate government role is to develop the technology and make it available to the private sector. At least two companies, Space Systems Loral (SSL) and Orbital ATK, are working on commercial satellite servicing programs. SSL won contracts from both NASA and DARPA to build the spacecraft for the RESTORE-L and RSGS missions. (Orbital ATK challenged the DARPA award, but the U.S. District Court for the Eastern District of Virginia dismissed the case on July 12, 2017.)

RESTORE-L is funded as part of NASA's Space Technology Mission Directorate (STMD). NASA budget documents show the line item for RESTORE-L as zero, but Acting NASA Administrator Robert Lightfoot told the Senate Appropriations CJS subcommittee on June 29, 2017 that the request includes $48 million for satellite servicing technology development (but none for demonstration).

Congressional Action. The House Appropriations Committee allocated $45.3 million in STMD for the RESTORE-L program as it currently exists calling it an "important program."

RESTORE-L is managed by Goddard Space Flight Center in Greenbelt, MD. Former Maryland Senator Barbara Mikulski was a strong proponent of the program and the top Democrat on the Senate Appropriations Committee and its CJS subcommittee. She retired in 2016 and many wondered if the committee would continue to support the program. The answer is yes. Her successor in the Senate and on the CJS subcommittee, Sen. Chris Van Hollen, strongly defended the program during the subcommittee's June 29, 2017 hearing. Joining him were West Virginia's two Senators, Joe Manchin (D) and Shelley Moore Capito (R), who also are members of the subcommittee. West Virginia University is participating in the program.

The Senate committee allocated $130 million for RESTORE-L, the same amount as FY2017. It added that it agrees DARPA's work is complementary and "encourages NASA to share expertise and lessons learned with DARPA and to accept any financial contributions from DARPA to its work."

NASA's FY2018 Appropriations as Part of the Bigger Budget Picture

NASA's appropriations are part of the Commerce-Justice-Science (CJS) bill, one of 12 appropriations bills on which Congress is supposed to act on each fiscal year.

The Appropriations Committees face a challenging task. They appropriate funds for the "discretionary" part of the federal budget, which is approximately one-third of total federal spending. The other two-thirds is for "mandatory" spending such as Medicare and Social Security and interest on the national debt, over which they have no jurisdiction.

Discretionary spending is divided into "defense" and "non-defense." NASA is part of non-defense discretionary spending.

The Trump budget proposal is to add $54 billion to defense and cut $54 billion from non-defense compared to the spending caps set by law in the 2011 Budget Control Act (BCA). The BCA sets total FY2018 discretionary spending at $1.065 trillion: $549 billion for defense and $516 billion for non-defense.

The BCA has been discussed in prior year versions of this fact sheet. In essence, if Congress exceeds the caps set by law, automatic across-the-board cuts called a "sequester" go into effect. The cuts are made equally to every defense and non-defense discretionary program regardless of their relative merits. That happened in FY2013. The resulting effects were so harmful that Congress and the White House agreed to relax the limits for FY2014-2015 and then for FY2016-2017, but the BCA caps extend through 2023 and there is no agreement for the remaining years. Trump said in his March 2017 budget blueprint that he "repeals" the sequester for defense spending, but he cannot repeal the law (Congress would have to do that), he can only ignore the caps, as did President Obama in FY2017. In Trump's case, he raised the amount for defense and cut non-defense by an equal amount, holding to the top line, but supporters of the non-defense programs oppose it. Proposed cuts to the State Department and foreign aid produced an immediate outcry and a leading Republican Senator, Lindsey Graham (R-SC), called the budget proposal "dead on arrival." That sentiment has been echoed by a number of Republicans and Democrats since.

Even supporters of defense spending are unhappy saying the proposed increase is too little. The chairmen of the House and Senate Armed Services Committees (Rep. Mac Thornberry and Sen. John McCain) both criticized the request as falling short of what Trump promised during his campaign and what is needed for a strong military.

Although NASA fared well in the Trump proposal compared to other non-defense agencies, it will be up to the appropriators to decide which programs to fund and which to cut.

The House Appropriations Committee is moving forward with approving appropriations bills. However, neither the House nor the Senate has passed a Budget Resolution that sets the total amount of money available for defense and non-defense programs in FY2018. How Congress will proceed with the appropriations process if they cannot agree on a Budget Resolution remains to be seen. There have been several years where no Budget Resolution passed, so it is possible to keep the government operating without one, but it complicates the situation.

House Appropriations Action

The House CJS subcommittee held its hearing on the NASA budget request on June 8, 2017. On June 29, it marked up its version of the CJS bill. The full committee approved the bill on July 13, making no changes to the NASA section. The House committee approved $19.872 billion, an increase of $780 million above the request and $218 million more than FY2017.

Senate Appropriations Action

The Senate Appropriations CJS subcommittee held its hearing on the NASA budget request on June 29, 2017. Republicans and Democrats especially questioned the reductions for education and RESTORE-L. Democrats also questioned the cuts to earth science. The subcommittee marked up the bill on July 25, 2017. Full committee markup tool place on July 27. The Senate committee approved $19.529 billion, $437 million more than the request, but $124 million less than FY2017.

Table 1: NASA's FY2018 Budget Request
(in $ millions, see notes below)

				Authorization			Appropriations		
Account	**FY2016 Approps**	**FY2017 Approps**	**FY2018 Request**	**House**	**Senate**	**Final**	**House Cmte**	**Senate Cmte**	**Final**
Science	**5,589.4**	**5,764.9**	**5,771.8**				**5,858.5**	**5,571.8**	
Earth Science	*1,921.0*	*1,921.0*	*1,754.1*				*1,704.0*	*1,921.0*	
Planetary Science	*1,631.0*	*1,846.0*	*1,929.5*				*2,120.9*	*1,611.9*	
Astrophysics	*730.6*	*750.0*	*816.7*				*822.0*	*816.7*	
JWST	*620.0*	*569.4*	*533.7*				*533.7*	*533.7*	
Heliophysics	*649.8*	*678.4*	*677.8*				*677.9*	*688.5*	
Education	*note 3 37.0*	*note 3*	*note 3*				*note 3*	*note 3 [44.0]*	
Aeronautics	**640.0**	**660.0**	**624.0**				**660.0**	**650.0**	
Space Technology	**686.5**	**686.5**	**678.6**				**686.5**	**700.0**	
Exploration	**4,030.0**	**4,324.0**	**3,934.1**				**4,550.0**	**4,395.0**	
Expl Sys Dev	*3,680.0*	*3,929.0*	*3,584.1*				*4,100.0*	*4,045.0*	
(Orion)	*(1,270.0)*	*(1,350.0)*	*(1,186.0)*				*(1,350.0)*	*(1,350.0)*	
(SLS)	*(2,000.0)*	*(2,150.0)*	*(1,937.8)*				*(2,150.0)*	*(2,150.0)*	
(Expl Ground Sys)	*(410.0)*	*(429.0)*	*(460.4)*				*(600.0)*	*(545.0)*	
Expl R&D	*350.0*	*395.0*	*350.0*				*450.0*	*350.0*	
Space Operations	**5,029.2**	**4,950.7**	**4,740.8**				**4,676.6**	**4,751.5**	
ISS	*N/A*	*N/A*	*1,490.6*				*N/A*	*N/A*	
Space Trans	*N/A*	*N/A*	*2,415.1*				*N/A*	*N/A*	
(Cmrcl Crew)	*(1,243.9)*	*(1,184.8)*	*(731.9)*				*N/A*	*note 4 732.00*	
(Crew and Cargo)	*N/A*	*(1,028.0)*	*(1,683.2)*				*N/A*	*1,683.2*	
Space & Flt Sprt	*N/A*	*N/A*	*835.0*				*N/A*	*N/A*	
Education	**115.0**	**100.0**	**37.3**				**90.0**	**100.0**	
Safety/Security/MS	**2,768.6**	**2,768.6**	**2,830.2**				**2,826.2**	**2,826.9**	
CECR	**388.9**	**360.7**	**496.1**				**486.1**	**496.1**	
Inspector General	**37.4**	**37.9**	**39.3**				**37.9**	**38.0**	
TOTAL	**19,285.0**	**19,653.3**	**19,092.2**				**19,871.8**	**19,529.3**	

Note 1: Columns may not add due to rounding. Text and numbers in *italics* are subtotals. Text and numbers in (*italics in parentheses*) are sub-subtotals. N/A = not applicable or not available. FY2016 and FY2017 appropriations figures are from the congressional appropriations documents. They often are adjusted by

NASA operating plans throughout the year so may not match what is in NASA's FY2018 budget request documentation. FY2018 House and Senate appropriations committee numbers are from the respective committee reports. The [$44 million] for education under the Science account in the Senate committee's FY2018 column in [brackets] indicates that the figure is not additive to the rest of the amounts shown. The committee only wanted to highlight that is the amount for education within the Science Mission Directorate.

Note 2: For information on the FY2017 request and congressional action, see the FY2017 version of this Fact Sheet. NASA's final FY2017 appropriations are in Division B of the Consolidated Appropriations Act, 2017 (P.L. 115-31), colloquially called "the omnibus"; these figures are from the bill and its accompanying explanatory statement.

Note 3: For FY2017, NASA incorporated funding for education-related activities in SMD within the astrophysics budget ($25 million) and the earth science budget ($6 million). Congress routinely breaks SMD education funding out into a separate line item, as shown here for FY2016. However, for FY2017, the Senate Appropriations Committee followed NASA's lead and allocated $42 million for education as part of the astrophysics budget. The FY2017 omnibus appropriations bill calls out the total in the text of the report, $37 million, but not in the accompanying table. The report states the money is to come equally from planetary science and astrophysics and managed for all of the Science Mission Directorate by the Astrophysics Division. For FY2018, the request within the Astrophysics Division is $44 million. The House Appropriations Committee approved the $44 million and directed that it be applied "proportionately" among the four SMD divisions. The Senate Appropriations Committee approved the $44 million and indicated that amount, in brackets, in its table for Science funding to highlight that is the amount for education. It is not additive to the total, however.

Note 4: The committee's press release summarizing subcommittee action on the bill stated that commercial crew was funded at this level, but it is not specified in the committee's report.

Table 2: Funding for the Space Launch System: NASA Request versus Congressional Appropriations (in $ millions)

	FY2014	FY2015		FY2016		FY2017		FY2018
Account: Subaccount	**Enacted**	**Request**	**Final**	**Request**	**Final**	**Request**	**Final**	**Request**
Exploration: Exploration Systems Development/ SLS	1,600.0	1,380.3	1,700.0	1,356.5	2,000.0 (incl $85 M for EUS)	1,310.3	2,150.0	1,937.8
Exploration: Exploration Systems Development/ Exploration Ground Systems	318.2	351.3	351.3	410.1	410.0	429.4	429.0	460.4
CECR: Exploration Construction of Facilities	*139.3	52.3	*67.9	10.0	*28.3	8.8	Not specified	*95.9
TOTAL	**2,057.5**	**1,783.9**	**2,119,2**	**1,776.6**	**2,410.0**	**1,748.7**		**2,494.1**

Notes: CECR = Construction, Environmental Compliance and Restoration. EUS is the Exploration Upper Stage, which is needed for SLS missions beyond Exploration Mission-1. NASA did not request EUS funding in FY2016.
* The $139.3 figure for FY2014 CECR is from NASA's FY2016 budget request. The CECR funding figure for FY2015 is from NASA's FY2017 budget book, p. EXP-19. Figures for FY2016 and the FY2018 request are from the FY2018 budget book, p. CECR-19, which does not show how much was allocated for FY2017. The CECR funding is for SLS, Orion and Exploration Ground Systems.