FY 2016 NASA Budget Comparison

Update 1

President's FY 2016 NASA Budget Request; FY 2015 Consolidated Appropriations Act (P.L. 112-235)

This document provides an overview of the President's FY 2016 NASA Budget request in comparison with the Consolidated Appropriations Act for FY 2015. The first section provides a comparison of funding levels provided by each top-line item. The analysis then looks in detail at the proposal within Science, Exploration, Space Operations, and Space Technology.

NASA Budget Proposals Overview – FY 2016 Funding

Budget Authority, $ in millions	Consolidated Approps, 2015 (P.L. 112-235)	President's FY 2016 NASA Base Budget Request
Science	5,244.700	5,289
Aeronautics Research	651.000	571.4
Space Technology	596.000	724.8
Exploration	4,356.700	4,506
Space Operations	3,827.800	4,004
Education	119.000	88.9
Safety, Security, and Mission Services (formerly Cross-Agency Support)	2,758.900	2,843
Construction and Environmental Compliance and Restoration	419.100	465.3
Inspector General	37.0005	37.4
Total	**18,010.2005**	**18,529.8**

Science

Budget Authority, $ in millions	Consolidated Approps, 2015 (P.L. 112-235)	President's FY 2016 NASA Budget Request
Earth Science	1,772.500	1,947
Planetary Science	1,437.800	1,361
Astrophysics	684.800	709
James Webb Space Telescope	645.4	620
Heliophysics	662.200	651
Education	42.0	--
Total	**5,244.7**	**5,289**

President's FY 2016 Budget Request for Overall Science Portfolio

In FY 2016, the President's base budget requested $5.289 billion for Science missions, $43.9 million above the funds appropriated for Science missions in FY 2015.

Earth Science

About

From space, NASA satellites can view Earth as a planet and enable the study of it as a complex, dynamic system with diverse components: the oceans, atmosphere, continents, ice sheets, and life. The Nation's scientific community can thereby observe and track global-scale changes, connecting causes to effects. Through partnerships with agencies that maintain forecasting and decision support systems, NASA improves national capabilities to predict climate, weather, and natural hazards, manage resources, and support the development of environmental policy.

- President's FY 2016 Earth Science Missions:
  - $348.4 million for Earth Science Research and Analysis;
  - $136.9 million for Computing and Management;
  - $127.4 million for Ice, Cloud, and land Elevation Satellite-2;
  - $15.9 million for Soil Moisture Active and Passive;
  - $66.3 million GRACE Follow-On;
  - $78.3 million for Surface Water and Ocean Topagraphy
  - $607.4 million for Other Missions and Data Analysis within Earth Systematic Missions;
  - $185.2 million for Venture Class Missions;
  - $825 million for Other Missions and Data Analysis within Earth Systems Science Pathfinder Missions;
  - $190.7 million for Earth Science Multi-Mission Operations;
  - $60.7 million for Earth Science Technology;
  - $47.6 million for Applied Sciences;
- "Building on NASA's successful launch of the NASA/USGS Landsat Data Continuity Mission (LDCM)/Landsat-8 mission in February 2013, the Administration's new Sustainable Land Imaging (SLI) program will provide US users with high-quality, global, land imaging measurements that are compatible with the existing 42-year record. The proposed program will address near- and longer-term issues of continuity risk; and will evolve flexibly and responsibly through investment in, and introduction of, new sensor and system technologies."
- The new SLI system is multi-decadal in nature and "involves three NASA mission/development activities, including initiation of Landsat 9 immediately in FY 2015, along with a fourth activity combining

technology investments and detailed system engineering to design and build a full-capability Landsat 10 satellite."

- NASA and NOAA Earth-observing satellite responsibilities are rearranged in the FY2016 budget request "to leverage NASA Earth Science's expertise in developing Earth-observing satellites while allowing NOAA to focus its development efforts on its weather satellites and weather forecasting mission."
- Accordingly, "NOAA will be responsible only for satellite missions that contribute directly to NOAA's ability to issue weather and space weather forecasts and warnings to protect life and property," While "NASA will be responsible for other nondefense Earth-observing satellite missions."
    - Beginning in FY16, responsibility for "TSIS-1 and future ocean altimetry missions (following Jason-3, which remains a NOAA mission)" will be transferred to NASA, while "geostationary and polar-orbiting weather satellites, radio occultation satellites, and space weather satellites" will remain NOAA's responsibility.

Planetary Science

About

To answer questions about the solar system and the origins of life, NASA sends robotic space probes to the Moon, other planets and their moons, asteroids and comets, and the icy bodies beyond Neptune.

- President's FY 2016 Planetary Science Missions:
    - $162.5 million for Planetary Science Research and Analysis;
    - $7.1 million for Directorate Management;
    - $50.0 million for Near Earth Object Observations;
    - $56.7 million for Other Missions and Data Analysis within Planetary Science Research;
    - $92.1 million for InSight;
    - $64.0 million for Other Missions and Data Analysis within Discovery;
    - $189.7 million for Origins-Spectral Interpretation-Resource Identification-Security-Regolith Explorer;
    - $69.3 million for Other Missions and Data Analysis within New Frontiers;
    - $411.9 million for Mars Exploration;
    - $116.2 million for Outer Planets;
    - $141.7 million for Technology;
- NASA's "two highest priority flagships" are the Mars 2020 Rover and the initiation of a Europa mission.
- The President's FY16 budget request includes $228 million for Mars Rover 2020. In 2015, "The Mars Rover 2020 mission will complete Phase A/Formulation with the SRR/Mission Definition Review and begin Phase B/Formulation."
- The President's FY16 budget request includes $30 million for Europa exploration, marking the first time that the President's budget "supports the formulation and development of a Europa Mission" and "allowing NASA to begin project formulation, Phase A."

Astrophysics

About

Having measured the age of the universe, the scientific community now seeks to explore its ultimate extremes: its birth, the edges of space and time near black holes, and the mysterious dark energy filling the entire universe. Scientists have recently developed astronomical instrumentation sensitive enough to detect planets around other stars.

- President's FY 2016 Astrophysics Missions:
    - $72.3 million for Astrophysics Research and Analysis;
    - $34.2 million for Balloon Project;
    - $81.1 million for Other Missions and Data Analysis within Astrophysics Research;

- $97.1 million for Hubble Space Telescope;
- $85.2 million for Stratopheric Observatory for Infrared Astronomy;
- $17 million for Other Missions and Data Analysis within Cosmic Origins;
- $107.6 million for Physics of the Cosmos;
- $64.2 million Exoplanet Exploration;
- $88 million for Transiting Exoplanet Survey Satellite;
- $62.4 million for Other Missions and Data Analysis within Astrophysics Explorer;

- The President's FY16 Budget Request "restores funding for the Stratospheric Observatory for Infrared Astronomy (SOFIA) mission," and notes that "the 2016 Senior Review panel will evaluate SOFIA's scientific productivity."

James Webb Space Telescope

About

The James Webb Space Telescope (JWST) is a large, space-based astronomical observatory. The mission is a logical successor to the Hubble Space Telescope, extending beyond Hubble's discoveries by looking into the infrared spectrum, where the highly red-shifted early universe must be observed, where relatively cool objects like protostars and protoplanetary disks emit infrared light strongly, and where dust obscures shorter wavelengths.

President's FY 2016 James Webb Space Telescope:

- $620 million for James Webb Space Telescope

Heliophysics

About

Using a fleet of sensors on various spacecraft in Earth orbit and throughout the solar system, NASA seeks to understand how and why the Sun varies, how Earth responds to the Sun, and how human activities are affected. The science of heliophysics enables the predictions necessary to safeguard life and society on Earth and outward journeys of human and robotic explorers.

- President's FY 2016 Heliophysics Missions:
  - $34 million for Heliophysics Research and Analysis;
  - $48.3 million for Sounding Rockets;
  - $21.6 million for Research Range;
  - $54.6 million for Other Missions and Data Analysis within Heliophysics Research;
  - $230.4 million for Solar Probe Plus;
  - $62.9 million for Solar Orbiter Collaboration;
  - $49.7 million for Other Missions and Data Analysis within Living with a Star;
  - $30.1 million for Magnetospheric Multiscale;
  - $20.4million Other Missions and Data Analysis within Solar Terrestrial Probes;
  - $49.8 million for ICON;
  - $49.2 million for Other Missions and Data Analysis within Heliophysics Explorer Program;
- The President's FY16 budget request "supports a gradual increase with a goal of fully implementing [the] DRIVE [Diversify, Realize, Integrate, Venture, Educate initiative] by the end of the decade.
- "The Heliophysics Explorer Program provides frequent flight opportunities for world-class scientific investigations on focused and timely science topics." NASA selects participants through a competitively-selected announcements of opportunity process. "Based on available funding, there is an expected three-year cadence. "Based on current funding projections, NASA can release the next Explorers AO no earlier than FY 2016."
  - Under the Heliophysics Explorer Program, the President's FY16 Budget Request supports continued development of ICON for launch in 2017.

- The President's FY16 budget request includes $230.4 to continue development of Solar Probe Plus, part of the Living with a Star program. The Solar Probe Plus will be ready for launch by 2018.

Exploration

Budget Authority, $ in millions	Consolidated Approps, 2015 (P.L. 112-235)	President's FY 2016 NASA Budget Request
Exploration Research and Development	306.4	399
Commercial Crew	805.0	1,244
Orion Multipurpose Crew Vehicle(s)	1,194.0	1,096
Space Launch System	1,700.0	1,356.5
Exploration Ground Systems	351.3	410
Total	**4,356.7**	**4,505.5**

President's FY 2015 Budget Request for Overall Exploration Portfolio

In FY 2015 the President base budget requested $4.505 billion for Exploration missions, $148.8 million above the funds appropriated for Exploration missions in FY 2015.

Space Launch System

About

- The NASA Authorization Act of 2010 directed NASA to develop an evolvable heavy-lift rocket that will allow human exploration beyond low Earth orbit. NASA FY 2016 budget justification documents note that "The vehicle's capabilities will evolve using a block upgrade approach, driven by near- and long-term exploration mission requirements."
  - First, "SLS will carry over 70 metric tons to low Earth orbit and nearly 30 metric tons to the exploration proving ground near the Moon."
  - Next, "follow-on upgrades, including an advanced Exploration Upper Stage (EUS) will improve vehicle lift performance to 105 metric tons to low Earth orbit and 40 metric tons to the lunar proving ground, significantly increasing mission capability."
  - Finally, "SLS will evolve to carry over 130 metric tons to low Earth orbit, necessary to launch the large elements needed for human exploration of Mars."
- EUS "leverages technology investments made by the STMD in areas such as cryogenic fluid management and advanced composites." NASA has already begun leveraging "this close coordination demonstrated between STMD and HEOMD" to serve as the basis for "future exploration technologies and capabilities needed to explore Mars in the 2030s."
- The President's FY16 request for SLS funding keeps the SLS EM-1 on track for launch capability readiness in November 2018.

Orion Multi-Purpose Crew Vehicle

About

NASA's FY 2014 budget justification documents states that Orion MPCV will be capable of carrying "a crew of four astronauts beyond Earth orbit and provide habitation and life support for up to 21 days." The spacecraft has three components: a crew module, service module, and launch abort system, with a separate adapter to connect the crew and launch vehicles.

- The crew module is described as a "familiar capsule shape on the outside, but inside it contains state of the art crew systems." During a mission the Orion MPCV will "house the crew, providing a safe environment within which to live and work." In addition, "Its advanced heat shield will protect the crew from the reentry heating during a high-speed return from beyond Earth orbit."
- The service module "is comprised of a crew module adapter and an ESA-designed and developed service module section, and together they provide in-space power, propulsion, and other life support systems."
- The launch abort system sits "atop the crew module," and "in the event of an emergency during launch or climb to orbit, will activate within milliseconds to propel the crew module away from the launch vehicle to safety." Further, the launch abort system "provides a protective shell that shields the crew module from dangerous atmospheric loads and heating during descent." The spacecraft will jettison the system "once Orion is out of the atmosphere and safely on its way to orbit."
- A successful EFT-1 Flight Test of the Orion Capsule was conducted in December 2014, the data from which "will help NASA to understand better many of the top risks to astronauts who will fly on Exploration Mission (EM)-2 and future missions."
- Next, "Orion will continue design, development, and testing, focusing on EM-1 and EM-2," while "NASA continues working toward a capability to launch EM-1, which includes launching an uncrewed vehicle to demonstrate the performance of an integrated SLS rocket and uncrewed Orion vehicle prior to EM-2, a crewed flight…. An integrated EM-1 launch date will be determined once the SLS, EGS, and Orion have completed their respective Critical Design Reviews."

Commercial Crew

About

With an eye to the future of human spaceflight, NASA is looking to the U.S. private sector to develop and operate safe, reliable, and affordable crew transportation to low Earth orbit, including to the International Space Station (ISS).

- In 2016, "commercial crew industry CCtCap teams will accomplish significant milestones under their contracts, such as Boeing's Integrated Parachute System Drop Tests and service module hot fire launch abort test and SpaceX's plans for uncrewed flight to ISS and Launch Site Operational Readiness Review."

Space Operations

Budget Authority, $ in millions	Consolidated Approps, 2015 (P.L. 112-235)	President's FY 2016 NASA Budget Request
International Space Station	-	3,106
Space and Flight Support	-	898
Total	**3,827.8****	**4,004**

*An amendment would transfer $7 million from Space Operations to the Space Technology account, but it is unknown what program the $7 million would be transferred from.
** The ISS and Space and Flight Support sub-numbers are not broken out for this account.

President's FY 2016 Budget Request for Overall Space Operations Portfolio

In FY 2016 the President base budget requested $4.004 billion for Space Operations missions, $175.9 million above the funds appropriated for Space Operations missions in FY 2015.

- President's FY 2016 Space Operations:
  - $1.1061 billion for ISS Systems Operations and Maintenance;
  - $394 million for ISS Research
  - $1.6055 for ISS Crew and Cargo Transportation
  - $23.3 million for 21st Century Space Launch Complex
  - $539.7 million for Space Communications Networks
  - $92.7 million for Space Communications Support
  - $108.5 million for Human Space Flight Operations
  - $86.7 million for Launch Services
  - $47.2 for Rocket Propulsion Test

International Space Station

About

As the world's only space-based multinational research and technology testbed, ISS is critical to the future of human space activities. The facility enables scientists to identify and quantify risks to human health and performance and to develop and test countermeasures and technologies to protect astronauts during extended human space exploration. In addition, ISS offers unique opportunities for research and development, allowing scientists to investigate biological and physical processes in an environment very different from that on Earth.

Space and Flight Support

About

Space and Flight Support consists of multiple programs providing Agency-level capabilities critical to the success of NASA missions and goals.

Space Technology

Budget Authority, $ in millions	Consolidated Approps, 2015 (P.L. 112-235)	President's FY 2016 NASA Budget Request
Space Technology Research and Development (formerly, the seperate Crosscutting Space Technology and Exploration Technology Development)	-	491.0
Agency Technology and Innovation	-	33.0
SBIR and STTR	-	200.9
Total	**596.0**	**724.8**

President's FY 2016 Budget Request for Overall Space Technology Portfolio

In FY 2016 the President base budget requested $724.8 million for Space Technology missions, $128.8 million above the funds appropriated for Space Technology missions in FY 2015.

About the Space Foundation

The foremost advocate for all sectors of the space industry and an expert in all aspects of space, the Space Foundation is a global, nonprofit leader in space awareness activities, educational programs that bring space into the classroom and major industry events, including the *Space Symposium*, all in support of its mission "to advance space-related endeavors to inspire, enable and propel humanity." The Space Foundation publishes *The Space Report: The Authoritative Guide to Global Space Activity* and provides three indexes that track daily U.S. stock market performance of the space industry. Through its Space Certification™ and Space Technology Hall of Fame® programs, the Space Foundation recognizes space-based technologies and innovations that have been adapted to improve life on Earth. The Space Foundation was founded in 1983 and is based in Colorado Springs, Colo. Its world headquarters features a public Visitors Center with two main areas - the El Pomar Space Gallery and the Northrop Grumman Science Center featuring Science On a Sphere®. The Space Foundation also conducts research and analysis and government affairs activities from its Washington, D.C., office and has a field office in Houston, Texas. For more information, visit www.SpaceFoundation.org. Follow us on Facebook, LinkedIn and Twitter, and read about the latest space news and Space Foundation activities in *Space Watch*.

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