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NASA Research Down, Spacecraft Funding Up in 2009

AAAS R&D Funding Update on R&D in the FY 2009 NASA Budget

(This analysis is a preview of the NASA chapter in the forthcoming *AAAS Report XXXIII: Research and Development FY 2009*, a comprehensive look at the President's budget for R&D in FY 2009. This analysis contains revised AAAS estimates of NASA R&D, different from figures originally presented in the President's budget. More tables and continually updated supplemental materials on R&D in the FY 2009 budget can be found on the AAAS R&D Web site at <http://www.aaas.org/spp/rd>.)

Highlights

- The National Aeronautics and Space Administration (NASA) budget would grow \$497 million or 2.9 percent to \$17.6 billion in 2009 (see Table II-12), with the entire increase and more going to two big-ticket human space programs. The Constellation Systems program to develop the next generation of human spacecraft would receive \$3.0 billion, an increase of 23.3 percent or \$576 million, including a billion dollars each for the Orion Crew Exploration Vehicle and the Ares I Crew Launch Vehicle. The International Space Station would receive \$2.1 billion, a \$247 million or 13.6 percent increase, as construction ramps up toward completion in 2010.

- But increases for these two programs would leave NASA's research-oriented programs in decline once more. NASA support of basic and applied research would fall for the fifth year in a row, down 5.2 percent in the 2009 request to \$3.1 billion. The Science portfolio would fall 5.6 percent to \$4.4 billion after a modest gain in 2008, with especially steep cuts in Astrophysics (down 13 percent) and Heliophysics (down 31 percent). Planetary Science (up 7 percent) and Earth Science (up 7 percent) would receive boosts, however, with a special emphasis on new earth science missions. Aeronautics research would continue to tumble with a 13 percent cut to \$447 million.

- The NASA R&D portfolio would increase 4.9 percent or \$592 million to \$12.8 billion (see Table II-12), with the entire increase and more coming from Constellation Systems and the Space Station.

NASA R&D in the FY 2009 Budget

The National Aeronautics and Space Administration (NASA) continues to forge ahead with its full program of flying the Space Shuttle, building the Space Station, funding research across a broad range of disciplines, and developing the next generation of space vehicles as part of the Vision for Space Exploration, but tight budget constraints in the overall federal budget and NASA Administrator Michael Griffin's promise to do everything within a budget rising no faster than the rate of inflation are forcing tough choices in the agency's priorities. NASA's total budget of \$17.6 billion in FY 2009 would be \$497 million or 2.9 percent more than the current year (see Table II-12), ahead of expected inflation but well below several NASA budgets from earlier this decade in real dollars (see Figure 1).

NASA's R&D funding would climb \$592 million or 4.9 percent to \$12.8 billion (see Table II-12 and Figure 1), continuing a rebound from a dismal 2005 when Shuttle cost overruns forced the agency to siphon money from R&D programs to the non-R&D Shuttle. **But efforts to develop next-generation human space vehicles to replace the Shuttle and ramped-up construction of the International Space Station (ISS) would take up the entire R&D increase and more, leaving all other NASA R&D programs combined with declining funding.**

NASA's Constellation Systems program aims to develop a new Orion Crew Exploration Vehicle (CEV) and Ares 1 Crew Launch Vehicle (CLV) to replace the Space Shuttle as the primary means of getting humans into space. This large program to fund development of the CEV, CLV, and related technologies is part of the President's Vision for Space Exploration, announced in 2004, to get humans back to the moon and onward to Mars. Funding for this effort has exploded in recent years (see Figures 1 and 2). The 2009 budget would boost funding by a remarkable 23 percent or \$576 million to \$3.0 billion, with the CEV and CLV receiving a billion dollars each. (Program budgets for all NASA programs appear to be significantly less than in previous years because of the proposed transfer of support costs to a separate Cross-Agency Support account (see Table II-12). Figures for all three years in Table II-12 have been adjusted to reflect the proposed transfer.) Although the longstanding goal has been to launch these vehicles in 2014, the current project timetable is working toward a launch date of 2015, with a mission to the moon by 2020.

Unfortunately, the current timetable would leave a gap of 5 years between the 2010 planned retirement of the Space Shuttle and the 2015 CLV launch when the U.S. will not have the capability to launch humans into space. During this time, NASA will have to rely on other nations, notably Russia, to transport astronauts to and from the International Space Station (ISS). The International Space Station (ISS) budget would climb 13.6 percent or \$247 million to \$2.1 billion in 2009 for a ramped-up construction schedule aiming for final assembly of the Station in 2010, followed by full operations through 2016 sustained by the purchase of Russian space flights to and from the Station after the Space Shuttle retires in 2010. The Space Shuttle, a non-R&D NASA program, is almost exclusively in operation to finish assembly of the Space Station with a \$3.0 billion request in 2009, down 8.7 percent. The current NASA plan is to have another \$3.0 billion Shuttle request in 2010 to finish Station assembly, but then retire the craft with less than \$100 million in 2011 for close-out costs. The Shuttle savings in 2011 and later would then be transferred to other NASA programs, primarily Constellation Systems.

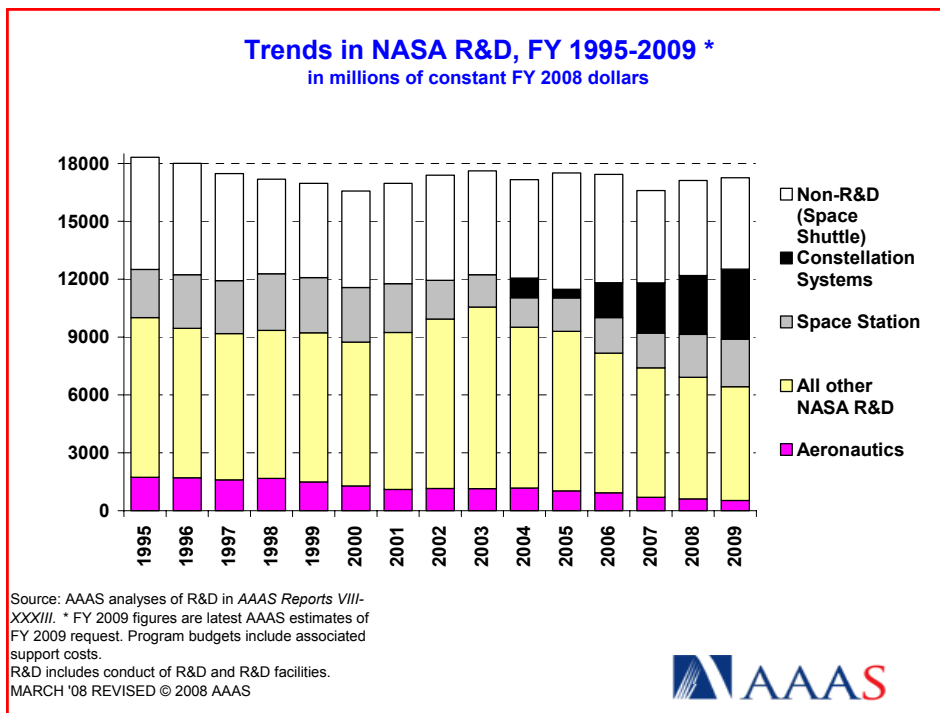


Figure 1. (click on image for PDF)

Together, the Constellation Systems increases for development and ISS increases for R&D facilities would take up the entire increase for NASA R&D, leaving all other NASA R&D programs combined with cuts, following similar cuts in each of the last five years (see Figure 1). Ironically, NASA is a large supporter of physical sciences research but was left out of the President's American Competitiveness Initiative (ACI) to boost basic physical sciences research, and its support for physical sciences research and

other research would continue to fall in the 2009 budget. **NASA's basic and applied research support would fall 5.2 percent or \$171 million down to \$3.1 billion, the fifth year in a row the NASA research portfolio would fall.** Aeronautics research funding would tumble 13 percent down to \$447 million in 2009 following similar cuts in previous years; in real terms, the aeronautics research portfolio would be less than half the 2004 portfolio (see Figure 1).

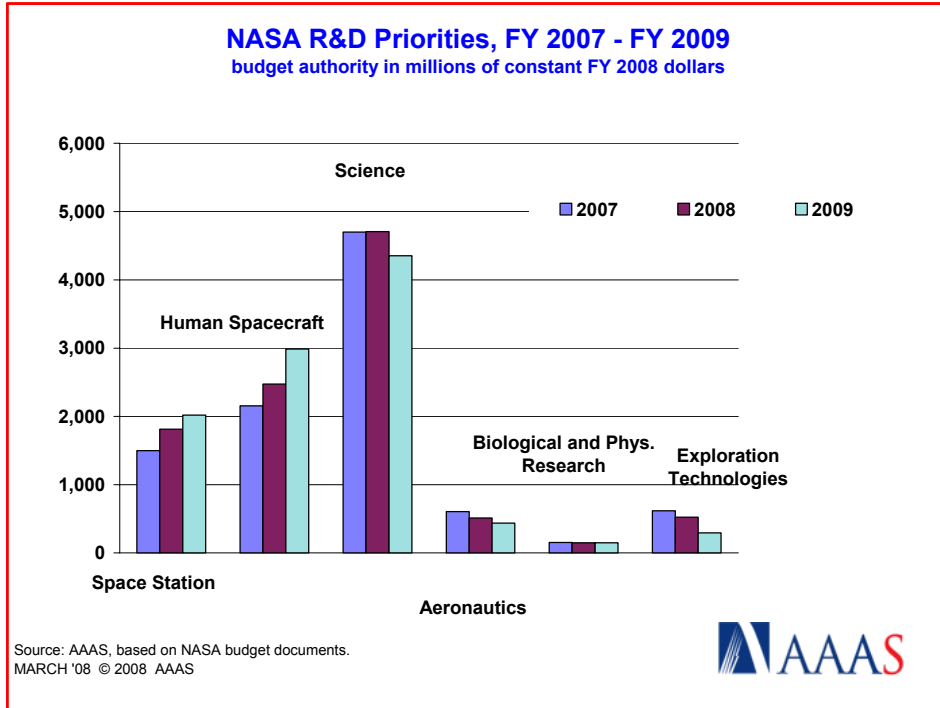


Figure 2. (click on image for PDF)

The Science portfolio of earth observations, astronomy, and robotic exploration of the solar system and universe would fall in 2009 after a slight increase in 2008 (see Figure 2). The Science portfolio would fall 5.6 percent to \$4.4 billion, with especially steep cuts in Astrophysics (down 13 percent) and Heliophysics (down 31 percent). Planetary Science (up 7 percent) and Earth Science (up 7 percent) would receive boosts, however, with a special emphasis on new earth science missions.

In the Earth Science portfolio (up 6.8 percent to \$1.4 billion), the 2009 request would attempt to rebuild a robust earth-observing capability after sharp cuts in earlier years. Last year, a National Academy of Sciences decadal survey of earth science expressed concern that the number of earth-observing sensors on NASA spacecraft could decrease by 40 percent during this decade if recent trends had continued. In response, NASA would add at least three new missions by 2013 compared to previous plans, and would boost funding for Earth Systematic Missions by 28 percent to \$678 million. The account funds costs for future missions such as the multi-agency NPOESS satellites, the Global Precipitation Measurement (GPM) mission, the Glory mission to measure aerosols, and the Landsat Data Continuity Mission. The account also funds operating costs for current missions such as Terra, Aqua, Aura, and the Tropical Rainfall Measuring Mission (TRIMM).

The Planetary Science portfolio would also receive a boost, of \$87 million or 7 percent to \$1.3 billion. While there have already been expressions of deep concern about a 30 percent cut in the Mars Exploration account down to \$387 million, due to the postponement of a launch within the 2011 launch window until the 2013 window and other program restructurings, other Planetary Science funding would increase. Outer Planets funding would increase 23 percent to \$101 million because of an added mission, Planetary Science Research funding would climb 12 percent to \$271 million for an expanded program of lunar research, New Frontiers funding would double to \$264 million to gear up for the launch of a Juno mission to Jupiter

beginning in 2011, and Discovery funding would climb 61 percent to \$247 million for early planning on a Gravity Recovery and Interior Laboratory (GRAIL) to investigate the lunar interior.

Astrophysics funding would fall 13 percent down to \$1.2 billion. Projected costs for the existing Hubble Space Telescope and the James Webb Space Telescope scheduled for a 2013 launch would fall. The Exoplanet Exploration program would suffer a 70 percent cut in funding to \$48 million as part of a tussle between Congress and NASA over the Space Interferometry Mission (SIM). After Congress boosted a \$22 million 2008 request to a \$54 million 2008 appropriation, NASA would zero out the SIM and put it back into the pool of candidates for a future mission. Astrophysics Research funding, however, would climb from \$102 million to \$152 million, and the restart of the Nuclear Spectroscopic Telescopic Array (NuSTAR) would help the Astrophysics Explorer program get a 23 percent increase to \$131 million.

Heliophysics funding would fall 31 percent down to \$577 million, but primarily because funding for Deep Space Mission Systems and Near Earth Networks would be transferred out of Science and into Space Operations. Heliophysics Research would begin to recover from past budget cuts with a modest \$4 million increase to \$185 million.

Impacts of the NASA Budget

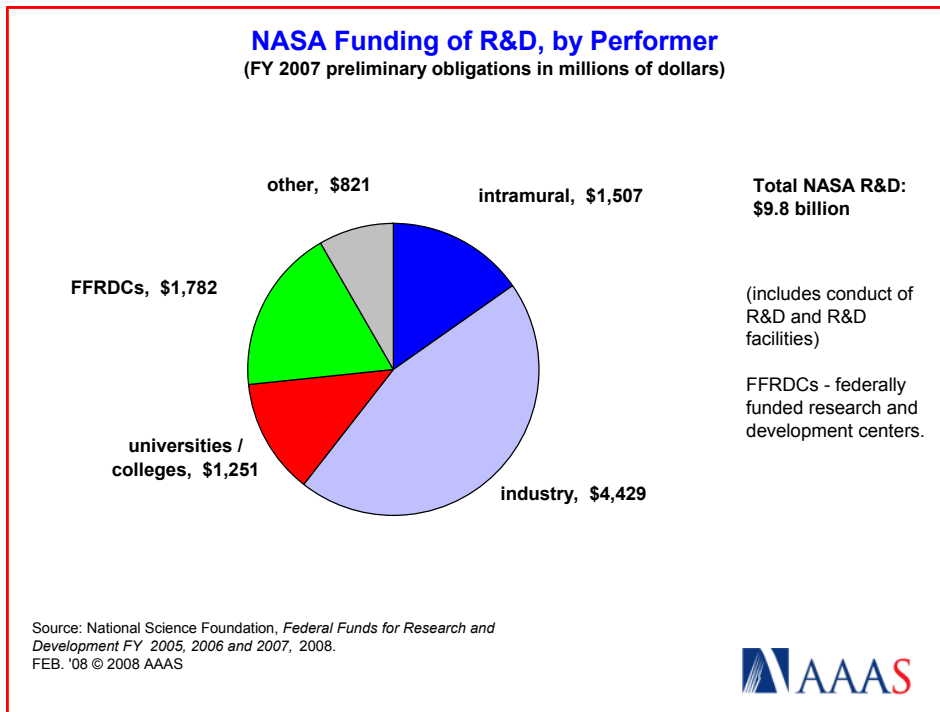


Figure 3. (click on image for PDF)

NASA's R&D funding has been essentially flat in real dollars going back to FY 1991. The proposed increase to NASA's R&D portfolio in FY 2009 would continue a modest upward trend for the last few years after hitting bottom in 2005, as shown in Figure 1, but research funding has been falling while development and R&D facilities funding have been increasing.. Although the Bush Administration's moon and Mars plan ignited hopes of increasing resources in a time of fiscal austerity, NASA committed to carrying out its ambitious plans with a budget plan that would just keep pace with expected inflation over the next decade. NASA's big plans for the next few years will require NASA to reshuffle its resources and to meet ambitious targets for deployment, construction, and then phase-out of the Space Shuttle and Space Station programs to make room for moon and Mars programs. Thus, NASA's R&D funding is likely to stay at this year's levels in inflation-adjusted dollars for the foreseeable future, with increases in priority

programs offset by cuts in other areas; in practice, this is likely to mean continuing cuts in NASA research to offset increases in development and R&D facilities.

Although much of NASA's R&D portfolio funds development and facilities projects, **NASA is responsible for 7 percent of all federal support for basic and applied research, with far larger roles in key fields.** Engineering research makes up the largest part of the NASA portfolio with a third of the total portfolio. NASA funds 16 percent of total federal support for engineering research. NASA supplies nearly all the federal support for some engineering sub-fields such as astronautical engineering and aeronautical engineering. NASA is the leading federal sponsor of the environmental sciences (oceanography, atmospheric sciences, geological sciences). The environmental sciences are a quarter of NASA's portfolio, and NASA accounts for a quarter of total federal support for environmental sciences research. NASA also invests heavily in the physical sciences (astronomy, chemistry, and physics). NASA is the second largest federal sponsor of physical sciences behind the Department of Energy, and is by far the leading sponsor of astronomy research with more than 70 percent of the federal total.

NASA's R&D is performed by a mix of performers. Industry performs nearly half of all NASA R&D (see Figure 3), because of industrial firms' key roles in big development and facilities projects such as the Space Station and Constellation Systems. NASA labs perform 15 percent of NASA R&D, while NASA's contractor-operated Jet Propulsion Laboratory (JPL) dominates in the Science portfolio and performs 18 percent of the R&D portfolio. NASA is also a significant though shrinking supporter of university research with \$1.3 billion in 2007, making the agency the fourth-largest federal sponsor of academic research behind the National Institutes of Health (NIH), the National Science Foundation (NSF), and the Department of Defense (DOD).

Outlook for the NASA Budget

There is growing congressional dissatisfaction over NASA's course of doing everything it has promised within a flat real budget. Congressional appropriators and authorizers have criticized the agency for siphoning resources away from research to keep the Space Shuttle, ISS, and moon and Mars programs on track, but have mostly been unable to come up with the additional money needed to sustain research. It remains to be seen whether the 2009 appropriations process will be any different: although lawmakers of both parties would like to boost NASA funding above the requested \$17.6 billion, they were unsuccessful in both 2007 and 2008.

(More materials on R&D in the FY 2009 budget, historical data and charts, and more information on *AAAS Report XXXIII: Research and Development FY 2009*, can be found on the AAAS R&D Web site at <http://www.aaas.org/spp/rd>.)

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Table II-12. NASA R&D

Table II-12. R&D in the National Aeronautics and Space Administration
(budget authority in millions of dollars)

	FY 2007 Actual	FY 2008 Estimate	FY 2009 Budget	Change FY 08-09	
				Amount	Percent
Detail of NASA Budget:					
1. Space Operations					
International Space Station	1,469	1,813	2,060	247	13.6%
Space Shuttle	3,315	3,267	2,982	-285	-8.7%
Space and Flight Support	329	446	733	287	64.2%
Total SPACE OPERATIONS	5,114	5,526	5,775	249	4.5%
2. Science					
Earth Science:					
Earth Science Research	350	376	381	5	1.3%
Applied Sciences	34	45	34	-12	-25.6%
Earth Sci. Multi-Mission Ops.	168	168	141	-27	-16.3%
Earth Systematic Missions	421	530	678	148	27.9%
Earth System Sci. Pathfinder	168	114	89	-25	-22.1%
Earth Science Technology	58	47	46	-1	-2.5%
Total Earth Science	1,199	1,280	1,368	87	6.8%
Heliophysics:					
Heliophysics Research	208	181	185	4	2.0%
Deep Space Mission Sys.	203	211	0	-211	-100.0%
Living with a Star	189	217	224	7	3.1%
Solar Terrestrial Probes	72	106	123	17	16.2%
Heliophysics Explorer Prog.	74	61	41	-20	-32.3%
Near Earth Networks	44	40	0	-40	-100.0%
New Millennium	41	26	4	-22	-83.3%
Total Heliophysics	831	841	577	-264	-31.4%
Planetary Science:					
Mars Exploration	635	554	387	-167	-30.2%
Discovery	128	153	247	94	61.4%
New Frontiers	107	132	264	132	99.6%
Technology	85	85	65	-20	-23.5%
Planetary Science Research	182	242	271	29	11.9%
Outer Planets	79	82	101	19	23.4%
Total Planetary Science	1,216	1,248	1,334	87	6.9%

(continued)

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Astrophysics:					
Astrophysics Research	99	102	152	50	49.0%
Cosmic Origins	791	807	674	-133	-16.5%
- <i>James Webb Space Telescope</i>	399	448	372	-76	-17.0%
- <i>SOFIA 1/</i>	39	62	73	11	17.2%
- <i>Hubble Space Telescope</i>	280	229	155	-74	-32.2%
Physics of the Cosmos	201	159	157	-2	-1.3%
Exoplanet Exploration	185	163	48	-115	-70.4%
Astrophysics Explorer	89	106	131	24	22.7%
Total Astrophysics	1,365	1,338	1,162	-175	-13.1%
Total SCIENCE	4,610	4,706	4,441	-265	-5.6%
3. Exploration					
Constellation Systems:					
Constellation Sys. Program	2,024	2,341	2,875	534	22.8%
- <i>Program Integ. & Ops.</i>	662	531	748	217	41.0%
- <i>Crew Exploration Vehicle</i>	480	776	1,101	326	42.0%
- <i>Crew Launch Vehicle</i>	882	999	1,019	19	1.9%
- <i>Other</i>	0	36	7	-29	-80.4%
Commercial Crew & Cargo	91	131	173	43	32.6%
Total Constellation Systems	2,115	2,472	3,048	576	23.3%
Advanced Capabilities:					
Lunar Precursor Robotic Prog.	247	198	56	-142	-71.6%
Exploration Tech. Development	359	326	244	-82	-25.1%
Human Research Program	149	147	152	5	3.4%
Total Advanced Capabilities	755	671	452	-219	-32.6%
Total EXPLORATION	2,870	3,143	3,500	357	11.4%
4. Aeronautics					
Aviation Safety	87	67	63	-4	-5.9%
Airspace Systems	103	100	75	-26	-25.5%
Fundamental Aeronautics	330	270	235	-35	-12.8%
Aeronautics Test Prog.	74	75	74	-1	-1.6%
Total AERONAUTICS	594	512	447	-65	-12.7%
5. Education	116	147	116	-31	-21.3%

(continued)

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Table II-12. R&D in the National Aeronautics and Space Administration
(budget authority in millions of dollars)

	FY 2007 Actual	FY 2008 Estimate	FY 2009 Budget	Change FY 08-09	
				Amount	Percent
6. Cross-Agency Support					
Center Mngmt. & Ops.	1,755	2,013	2,046	33	1.6%
Agency Mngmt. & Ops	971	830	946	115	13.9%
- <i>Innovative Partnerships</i>	189	147	176	29	19.7%
Institutional Investments	224	320	309	-11	-3.4%
Congressional Projects	0	80	0	-80	-100.0%
Total CROSS-AGCY. SUPPORT	2,950	3,243	3,300	57	1.8%
7. Inspector General					
undistributed rescission	32	33	36	3	8.9%
	0	-193	0	193	-100.0%
TOTAL NASA Budget	16,285	17,117	17,614	497	2.9%
<i>minus non-R&D activities:</i>					
<i>Space Shuttle</i>	-3,315	-3,267	-2,982	-285	-8.7%
<i>Space and Flight Support</i>	-329	-446	-733	287	64.2%
<i>Inspector General</i>	-32	-33	-36	3	8.9%
<i>Education</i>	-116	-147	-116	-31	-21.3%
<i>Cross-Agcy. Support for Non-R&D</i>	-889	-1,013	-948	-64	-6.4%
<i>Education & Training</i>	-21	-24	-20	-3	-13.8%
TOTAL NASA R&D	11,582	12,188	12,780	592	4.9%

Source: OMB R&D data for FY 2009, agency budget justification, and agency documents.
All figures are rounded to the nearest million. Changes calculated from unrounded figures.

NASA has proposed to restructure its programs in FY 2009.

Figures for all years have been adjusted to reflect the proposed structure.

Most program budgets are significantly less than in previous years because of the transfer of costs to Cross-Agency Support.

These data have been adjusted by AAAS to include R&D support costs in Cross-Agency Support as R&D funding, in line with historical trends.

1/ Stratospheric Observatory for Infrared Astronomy

Please see Chapter 9 for a discussion of NASA R&D.

March 6, 2008 - revised