Order Code RL30493

CRS Report for Congress
Received through the CRS Web

The National Aeronautics and Space Administration's FY2001 Budget Request and FY2001-FY2002 Authorization: Description and Analysis

Updated January 13, 2001

Richard E. Rowberg
Senior Specialist in Science and Technology
Resources, Science, and Industry Division

Erin Hatch
Analyst in Space and Technology Policy
Resources, Science, and Industry Division

The National Aeronautics and Space Administration's FY2001 Budget Request and FY2001-FY2002 Authorization: Description and Analysis

Summary

For FY2001, NASA requested $14.035 billion, an increase of 3.2% above the FY2000 appropriations. This was the first budget increase requested by NASA in seven years. Of the request, $9.73 billion is for R&D, an increase of 0.8% above the FY2000 level. NASA requested an increase of $206 million for Space Science and $69.9 million for Aero-Space Technology. The agency requested a decrease of $208.6 million for the International Space Station.

In its request, NASA proposed a five-year, $4.4 billion ($290 million for FY2001) effort to develop the technology base for a 2nd generation reusable launch vehicle (RLV), and a 10-year, $1.7 billion ($20 million for FY2001) program — Living With a Star — to study the origins of eruptions on the Sun's surface that can result in damage to Earth satellites. Another initiative in the request was a five-year, $1.9 billion effort for safety and supportability upgrades for the Space Shuttle.

The budget request highlighted several issues that were considered by the 106th Congress. A perennial concern was U.S. reliance on Russia for construction of the ISS, and the problems Russia is having in meeting its commitments. An issue that intensified this past year was whether NASA's "faster, better, cheaper" policy about deployment of its scientific missions resulted in too many failures and not enough attention to the scientific objectives of the mission. Concerns were also raised about NASA's plans to develop a follow-on RLV to the Space Shuttle. In the meantime, there was growing concern about the safety and reliability of the shuttle, although the shuttle upgrade program proposed by NASA could address those concerns. It is likely that these issues will continue to be important for the 107th Congress.

On October 27, 2000, the VA/HUD appropriations bill for FY2001 (P.L. 106-377, H.Rept. 106-988) was signed providing $14.285 billion for NASA, 1.8% above the request and 5.0% above FY2000. Included in the amount is a shift, proposed by NASA subsequent to the initial budget request, of $75 million to the Mars 2003 Lander program from other NASA programs. All other programs are being funded at or above the level requested originally including the Living With a Star and 2nd generation RLV initiatives.

On October 30, 2000, the NASA authorization bill for FY2001 and FY2002 became law (P.L. 106-391 and H. Rept. 106-843). The Act authorizes $14.184 billion for FY2001 and $14.465 billion for FY2002. The Living With a Star and 2nd generation RLV initiatives were both authorized. In addition, Act put a cap of $25 billion on total ISS development costs with a 20% contingency fund to cover "urgent situations" that may arise. The 106th Congress also expressed support for the "faster, better, cheaper" concept, while urging NASA to improve its implementation.

Contents

Introduction 1
Historical Budget 1

NASA Programs and FY2001 Budget Request 2
Overview 2
Human Space Flight 4
International Space Station (ISS) 4
Space Flight Operations 8
Payload and ELV Support 9
Investments and Support 10
Science, Aeronautics, and Technology 10
Space Science 11
Life and Microgravity Sciences and Applications 15
Earth Science 16
Aero-Space Technology 19
Space Operations 22
Academic Programs 24
Mission Support 25
Safety, Mission Assurance, Engineering, and Advanced Concepts . . 25
Research and Program Management 26
Construction of Facilities 26

Outyear Budget Projections 27

List of Tables

Table 1. NASA FY2001 Budget — Appropriations 3
Table 2. NASA Authorization – FY2001-FY2002 6
Table 3. NASA FY2001 and Outyear Budget Estimate 27

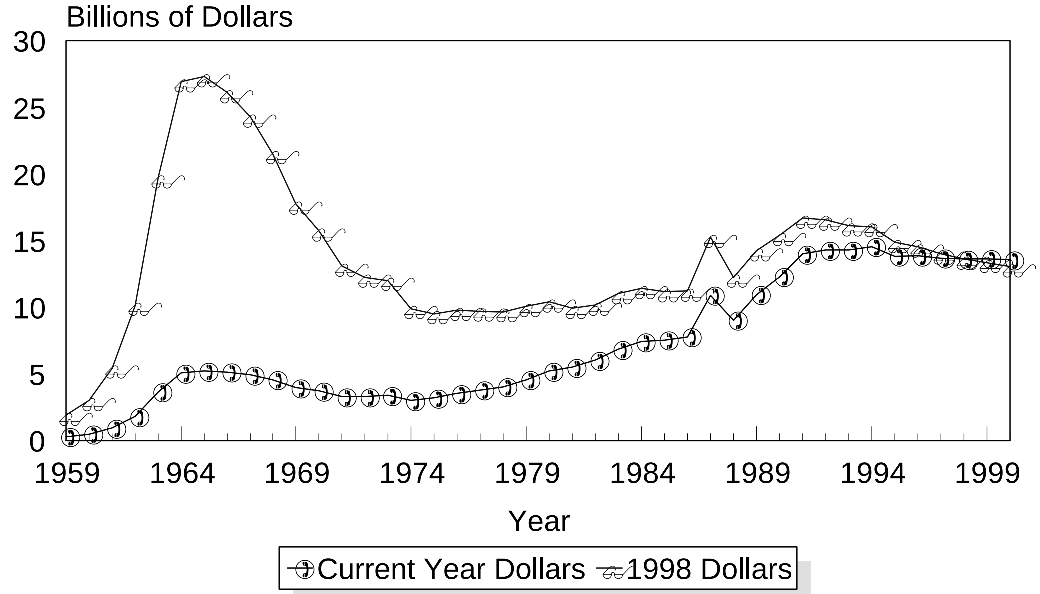
The National Aeronautics and Space Administration's FY2001 Budget Request and FY2001-FY2002 Authorization: Description and Analysis

Introduction

The National Aeronautics and Space Administration (NASA) was created by the National Aeronautics and Space Act of 1958 (P.L. 85-568) to undertake civilian research, development, and flight activities in aeronautics and space. This report describes the various NASA programs, NASA's FY2001 budget request, and disposition of that request by the 106th Congress. Included are discussions of key issues that affected congressional actions on the budget and that may reemerge in the 107th Congress.

Historical Budget

Since its creation, NASA has experienced periods of budget growth and decline, some of which have been quite dramatic. In the early 1960s, as the nation strived to put an American on the Moon by 1969, NASA's budget increased rapidly, peaking at $5.25 billion in FY1965. Then, as other national priorities gained precedence,



Source: Aeronautics and Space Report of the President, FY1997 Activities: NASA, *FY2001 Budget Request*

NASA's budget declined sharply from the FY1965 peak to about $3 billion in FY1974. After FY1974, NASA's budget once again began to increase steadily, peaking at $14.5 billion in FY1994. As efforts to restrain federal funding took hold under the pressure of the budget caps, NASA's budget again began to decline to its FY2000 level of $13.600 billion. Figure 1 (previous page) displays the agency's budget history, both in current year dollars (unadjusted for inflation) and in 1998 dollars. (The one-year spike in 1987 was to build a replacement orbiter following the *Challenger* tragedy.) The sharpness of the budget growth and decline from 1958 to 1974 is quite clear when presented in 1998 dollars.

NASA Programs and FY2001 Budget Request

Overview

NASA's budget[1] request was presented in four appropriations categories: Human Space Flight (HSF), Science Aeronautics and Technology (SAT), Mission Support (MS), and the Inspector General (IG).[2] For FY2001, NASA requested $14.035 billion, an increase of 3.2% above the FY2000 appropriations. This is the first increase requested by NASA in seven years. Of the request, $9.73 billion was for R&D, an 0.8% above the FY2000 level. Funding for the R&D programs contained within the SAT category would increase by 6.2% while funding for the International Space Station, in the HSF category, would decrease by 9%.

NASA stated that its FY2001 budget request was designed around four key priorities: operate the space shuttle safely; continue construction of the International Space Station; make progress toward reducing the cost of access to space; and perform outstanding science and technology. In addition, the budget request proposed two changes in the major account structure. First it converted the Payload Utilization and Operations account into two new accounts: Payload and ELV (expendable launch vehicle) Support, and Investments and Support. This action was designed to separate activities that support the shuttle and NASA's ELV program from those that provide broad support for all of NASA's human space flight (HSF) activities. The second action combined Mission Communication Services and Space Communications Services into one account, Space Operations. These two programs perform similar functions. NASA is combining their activities under the Consolidated Space Operations Contract (CSOC).

For FY2001, NASA also is increasing its full-time equivalent workforce by 328 people following several years of decline. NASA stated that it wishes to stabilize its workforce and rebalance the skill mix. This follows from growing concerns that the losses in personnel during the last several years of downsizing might be adversely affecting NASA's technical capabilities.

---

[1] For budget details, see, National Aeronautics and Space Administration, *Budget Estimates: Fiscal Year 2001*, [http://ifmp.nasa.gov/codeb/budget2001/].

[2] The NASA budget supports its four strategic enterprises: the Space Science Enterprise, the Earth Science Enterprise, the Human Exploration and Development of Space Enterprise, and the Aero-Space Technology Enterprise. See: NASA *Budget Estimates*, AS2-3.

On October 27, 2001, the FY2001 VA/HUD appropriations bill was enacted (P.L. 106-377, H.Rept. 106-988) providing $14.285 billion for NASA for FY2001, 1.8% above the request and 5.0% above the FY2000 level. Details are provided in table 1 below. The 106th Congress directed NASA to develop a comprehensive and strategic plan for its centers including a 10-year mission schedule that identifies the

Table 1. NASA FY2001 Budget — Appropriations
(millions of dollars)

Funding Category	FY2000 (Appro.)	FY2001 (Request)	FY2001 (House)	FY2001 (Senate)	FY2001 (Conf)
HUMAN SPACE FLIGHT	**5,467.7**	**5,499.9**	**5,472.1**[a]	**5,462.9**	**5,462.9**
Space Station	2,323.1	2,114.5	2,114.5		2,117.5
Space Shuttle	2,979.5	3,165.7	3,165.7		3,125.7
Payload Utilization and Operations	165.1				
Payload and ELV Support		90.2	90.2		90.2
Investments & Support		129.5	129.5		129.5
SCIENCE, AERO, AND TECH	**5,580.9**	**5,929.4**	**5,579.5**[b]	**6,190.7**[c]	**6,190.7**[c]
Space Science	2,192.8	2,398.8	2,378.8		2,508.3
Life and Microgravity Sciences	274.7	302.4	329.0		316.9
Earth Science	1,443.4	1,405.8	1,405.8		1,498.1
Aero-Space Technology	1,124.9	1,193.0	859.0		1,253.2
Space Operations		529.4	529.4		529.4
Mission Communications Services	406.3				
Academic Programs	138.8	100.0	105.4		134.0
MISSION SUPPORT	**2,532.2**	**2,584.0**	**2,584.0**	**2,608.7**	**2,608.7**
Safety& Mission Assurance	43.0	47.5	47.5		47.5
Space Communications Services	89.7				
Research and Program Manag	2,217.6	2,290.6	2,290.6		2,286.8
Construction of Facilities	181.9	245.9	245.9		274.4
INSPECTOR GENERAL	**20.0**	**22.0**	**23.0**	**23.0**	**23.0**
TOTAL	**13,600.8**	**14,035.3**	**13,658.6**	**14,285.3**	**14,285.3**

[a] The total has been reduced by $27.8 million to account for amendments adopted by the House, which has not been allocated to the individual programs.
[b] The total has been reduced by $27.2 million to account for amendments adopted by the House, which has not been allocated to the individual programs.
[c] This total was reduced by a general reduction of $49 million, which has not yet been allocated to the individual programs.
Source: NASA *FY2001 Budget Estimate*

lead center for each mission. The 106th Congress, in prescribing reprogramming procedures, warned NASA that no change was to be made in a program account if that action constituted a change in policy. Further, NASA is directed to make no reduction or reprogramming in any program specifically identified by the 106th Congress in the conference report without prior approval. The 106th Congress also gave NASA authority to offer buyout authority in order to reduce personnel levels for specific activities it deems as having excess staff, while not having to reduce total full-time equivalent personnel for the entire agency. This action is designed to give NASA more flexibility in adjusting its skill mix. The 106th Congress also expressed its concern about the effect of the adoption of full-cost accounting on the program and financial information it is provided by NASA. It stated that NASA should be ready to provide [the 107th] Congress with any information needed in the event it finds the initial submissions inadequate.

Table 2 (page 5) shows authorization action for the 106th Congress. On October 30, 2000, the NASA Authorization Act of 2000 (P.L. 106-391 (H.R. 1654), H.R. 106-843) was signed. The Act authorizes $14.184 billion for FY2001 and $14.625 billion for FY2002.

In the conference report with the NASA authorization act, H.Rept. 106-843, the 106th Congress noted the significant changes in the FY2001 NASA budget request compared to that delivered with the FY2000 request in 1999. Those changes were primarily a result of new initiative with the FY2001 budget request and funding for the ISS had passed its peak. Accordingly, the conferees made changes in the FY2001 NASA authorization act to reflect these developments.

Human Space Flight

The Human Space Flight account includes funding for the International Space Station, Space Flight Operations (space shuttle), Payload and ELV Support, and Investments and Support. Total request for the HSF account for FY2001 was $5.500 billion compared to $5.468 billion approved for FY2000. The enacted FY2001 appropriations provides $5.462 billion, 0.7% below the request and 0.1% below the FY2000 level. NASA had proposed a budget adjustment that would reduce the HSF account by $40 million in order to provide more funds for the Mars 2003 lander. This adjustment was agreed to in the final act. Under these conditions, the final amount approved for the HSF account for FY2001 was just $3 million above the request.

International Space Station (ISS). The principal ISS mission is to establish permanent human presence in space.[3] The station will serve as a platform for a range of research activities in biology, physics, and materials science, as well as for Earth and astronomical observations. NASA also hopes that experience gained by using the ISS will facilitate decisions about the future of its Human Exploration and Development of Space enterprise. NASA considers the ISS as central to fulfilling that enterprise, including the commercial exploitation of space. The agency hopes that the ISS will attract a substantial number of commercial ventures, and that an increasing fraction of the ISS operational costs will be covered by the private sector.

For FY2001, NASA requested $2.114 billion for the ISS, 9% below the FY2000 appropriation, reflecting a planned decline as hardware for the station is completed. Currently, three elements of the space station are in orbit. The most recent was the Service Module built by Russia and successfully launched in July 2000.

NASA requested $442.6 million for the ISS vehicle, down from $890.1 million approved in FY2000. The ISS Vehicle program supports development of the

---

[3] For a complete discussion of ISS issues, see CRS Issue Brief IB93017, *Space Stations*, by Marcia Smith.

hardware to be installed on the station. The successful launch of the Russian Service Module in July means that station assembly will continue in FY2001 as outlined in the FY2001 budget request. Seven shuttle flights are now scheduled, including installation of truss assemblies for supporting photovoltaic arrays and six systems racks including the Human Facility Rack.[4] The latter will provide the station, for the first time, with the capability to support research. The first extended stay by a crew began in November 2000. Installation of an airlock is also planned for FY2001.

For space station operations capability, NASA requested $826.5 million for FY2001, up from $763.6 million approved for FY2000 . This activity's objective is to assemble and operate the space station. Space station operations includes operation of the station in flight and the associated ground operations. A major objective of operations capability is to ensure that all operations are safe, reliable, and sustainable. NASA began permanent habitation of the ISS in November 2000. Three different crews are planned to be on board the station during FY2001, and training is being carried out for the three crews scheduled for FY2002. Seven shuttle flights will be supported by operations during FY2001. In addition to the crews, these flights will transport additional research and stowage racks. The operations activity is also responsible for integrating all foreign contributions to the ISS. During FY2001, an Italian-built logistics module and a Canadian-built mechanical arm are planned for delivery to the station.

NASA requested $455.4 million for FY2001 for space station research, an increase of $61 million over the FY2000 appropriation. The objective of space station research is to develop the facilities — human research facility racks — and procedures to carry out research on the space station in the areas of biology, physics, and materials science. In addition, this activity supports research in those fields and will direct the transition from the current short-term focus of research now carried out on the space shuttle to a long-term focus made possible by the ISS. For FY2001, research using the first human research facility rack is underway. Research will focus on understanding how humans adapt to living in space for long periods and the development of ways to mitigate undesirable effects. To assist with this research, NASA plans to deploy four smaller, focused racks — called EXPRESS racks — during FY2001. Also, NASA is continuing fabrication and assembly of several other research racks and facilities permitting research on a variety of subjects.

The final component of the space station program budget request is the Crew Return Vehicle (CRV) project, for which NASA requested $90 million for FY2001. This project's objective is the development of a vehicle that could return up to seven ISS crew to Earth in the event of an emergency. The first of four crew return vehicles will be required for the ISS by FY2004. For FY2001, NASA is continuing Phase 1 of the CRV program which involves conversion of the X-38 design into a CRV design. The X-38 project is designed to develop the technology base for a CRV. A space flight test is planned for FY2002. Upon completion of Phase 1, NASA will decide whether to proceed with an X-38-based design of a CRV. Funding for that phase, Phase 2, would no longer be in the ISS account, but would

---

[4] A rack is the assembly in which specific scientific experimental facilities, or associated equipment, will be mounted.

Table 2. NASA Authorization – FY2001-FY2002

Funding Category	FY2000 (Appro)	FY2001 (Request)	FY2001 (H.R. 1654)	FY2002 (H.R. 1654)	FY2001 (S. 342)	FY2002 (S. 342)	FY2001 (Conf)	FY2002 (Conf)
HUMAN SPACE FLIGHT	**5,487.9**	**5,499.9**	**5,499.9**	**5,355.3**	**5,653.5**	**5,520.3**	**5,499.9**	**5,387.6**
International Space Station		2,114.5	2,114.5	2,091.0	2,328.0	2,091.0	2,144.5	1,858.5
Space Shuttle	2,323.1	3,165.7	3,165.7	3,043.0	3,105.8	3,208.0	3,165.7	3,307.8
Payload/ELV Support	2,979.5	90.2	90.2	90.3	90.2	90.3	90.2	90.3
Investments and Support		129.5	129.5	131.0	129.5	131.0	129.5	131.0
SCIENCE, AERO, AND TECH	**5,580.9**	**5,929.4**	**5,636.8**	**5,831.6**	**5,768.4**	**6,062.9**	**6,078.5**	**6,548.9**
Space Science	2,192.8		2,315.2	2,411.8	2,262.5	2,330.4		
Life and Microgravity Sciences	274.7	2,398.8	335.2	344.0	263.9	271.8	2,417.8	2,630.4
Earth Science	1,443.4	302.4	1,413.3	1,365.3	1,502.9	1,548.0	335.2	344.0
Aero-Space Technology[a]	1,124.9	1,405.8	918.4	1,003.3	1,036.7	1,067.8	1,430.8	1,357.5
Space Operations	585.7	1,193.0	491.4	470.8	527.8	605.2	1,224.0	1,574.9
Academic Programs	100.0	529.4	128.6	130.6	133.9	133.9	529.4	500.8
Future Planning	0	100.0	144.0	280.0	150.0	280.0	141.3	141.3
MISSION SUPPORT	**2,494.9**	**2,584.0**	**2,530.3**	**2,675.8**	**2,569.7**	**2,646.8**	**2,584.0**	**2,666.2**
Safety, Mission Assur, Eng & Adv Concept	43.0	47.5	45.0	49.0			47.5	51.5
Research and Program Management	2,181.2	2,290.6	2,195.0	2,261.6			2,290.6	2,383.7
Construction of Facilities	181.0	245.9	181.0	191.0			245.9	231.0
INSPECTOR GENERAL	**20.8**	**22.0**	**22.0**	**22.0**	**21.4**	**22.1**	**22.0**	**22.7**
TOTAL	**13,578.4**	**14,035.3**	**13,757.1**	**13,847.9**	**13,967.4**	**14,214.2**	**14,184.4**	**14,625.4**

[a] In October 1998, NASA changed the name of the Office of Aeronautics and Space Transportation Technology to the Office of Aero-Space Technology

Source: NASA *FY2001 Budget Estimate* and Authorization Bills.

be transferred to the Office of Aero-Space Technology. As a contingency, NASA plans to buy two Russian Soyuz vehicles, which would increase reliance on Russia.[5]

For FY2001, the NASA appropriations act provides the entire request for the ISS for FY2001. plus $3 million for design of a Bioastronautics facility (see below).

The FY2001 NASA authorization act bill provides $2.114 billion for the ISS for FY2001 and $1.858 billion for FY2002. These lower levels reflect the fact that annual funding for the ISS has passed its peak. The 106th Congress also directed that $451.6 million of ISS funds for FY2001 be set aside for ISS research to be managed by the OLMSA. In addition, $20 million for FY2001 and FY2002 is authorized for Technology and Commercialization.

Perhaps none of NASA's programs has generated more controversy than the ISS. Despite the successful launch in 1998 of the first two major components of the station, the station continued to encounter problems during 1999. While the successful launch of the Russian Service Module in July was a significant event, there is still concern about whether the Russians will be able to meet all its commitments to the station. One consequence of this uncertainty is that NASA requested $300 million for FY2001 to fund ISS efforts that might be needed in the even key Russian contributions are not forthcoming or are excessively delayed. For FY2001 NASA expects most these funds to be used to continue development of the propulsion module that would be needed in case Russia is not able to provide reboost flights throughout station assembly. It is important to note that those funds would not be transferred to Russia, but would be used by NASA to procure substitute services and facilities. Even that amount, however, might not be sufficient.

In the appropriations bill conference report, the 106th Congress recognized the need to conduct biomedical research in order to determine the best way to protect long-term inhabitants of the ISS. It also noted that this research was a principal objective of the Bioastronautics Initiative and, in particular, a Bioastronautics facility being constructed at the Johnson Spaceflight Center. Accordingly, the 106th Congress provided an additional $3 million to complete the design of this facility. It also included a provision directing the development of a 10-year ISS-related research plan including consideration of a variety of research management options. The 106th Congress also stated that the Committees on Appropriations must have such a plan before the 107th Congress can approve final funding for any management arrangement. Accordingly, the 106th Congress prohibited the use of funds to implement any management agreement prior to December 1, 2001.

In the authorization bill conference report, H.R. 106-843, the 106th Congress expressed concern about the cost overruns on the propulsion module project,

---

[5] Russian Soyuz spacecraft are planned be used for emergency escape for U.S. crews until a CRV is ready. Each Soyuz can only hold a three-person crew, however, limiting ISS crew size, and the Soyuz must be replaced every six months, increasing operations costs. Those limitations are the reasons why NASA is in the process of building a more capable CRV, which can hold up to seven crew and would need to be replaced only once every three years.

particularly given that the project was in its early stages. It noted the current lack of specific future plans for the module. The 106th Congress also directed NASA to deliver bimonthly reports on the Russia's status in meeting its commitments and to notify the 107th Congress if NASA decided to replace any critical Russian element or launch service. The 106th Congress also directed NASA to seek assurances from Russia that it place the ISS on a higher priority than the Mir space station, and it placed a limit of $25 billion on ISS development and $17.7 billion for shuttle flights necessary for "substantial completion" of ISS assembly. The authorization act provides an additional 20% for contingencies for both ISS development and the shuttle flights. The contingencies are to be reserved for any "urgent situation" on the ISS, particularly those that would affect crew safety or ISS integrity. The 106th Congress also repeated its concern about the need to maintain the capabilities of space-based life and microgravity research during ISS development. It noted that it has provided funding for a shuttle flight dedicated to such research and that the House version of the authorization bill called for a National Research Council review of how ready the U.S. scientific community is to use the ISS. Finally, the 106th Congress directed NASA to establish an agreement with an non-government organization to manage both research and commercialization activities for the ISS. Such an organization should be selected competitively and should include expertise from the research community and from industry.

Space Flight Operations. The function of this program is to operate and maintain the Space Shuttle and carry out shuttle safety and performance upgrades.[6] NASA missions are the primary customer of the shuttle, although industry, academia, and international entities use shuttle services, usually on a reimbursable basis. Currently, the Space Shuttle program is designed for an average of seven launches per year.

For FY2001, NASA requested $3.166 billion for this program, an increase of $186.2 million from the amount approved for FY2000. Included in the FY2001 request are $2.006 billion for flight hardware, $555.1 million for ground operations, $273.6 million for flight operations, and $334.4 million for program integration. Nine flights are now planned for FY2001. In addition, upgrades to combat obsolescence — supportability upgrades — are to be funded in FY2001. NASA has also embarked on a major safety upgrade activity designed to improve reliability and ensure safe operations for the next decade. An independent review panel has been established by NASA to determine the priorities for these upgrades, which are now planned to be completed by 2005. The size of the Space Flight Operations (SFOC) contract will grow in FY2001 as more shuttle operations are added to that contract. The SFOC is designed to consolidate all shuttle operations under one contract and currently accounts for about one-half of the program's budget.

The FY2001 appropriations act did not give a specific figure for space shuttle operations, but it can be inferred from the conference report that the amount provided is equal to the adjusted request, $3,125.7 million. As noted above, NASA asked to

---

[6] For a more extensive discussion on space launch issues, see: CRS Issue Brief IB93062. *Space Launch Vehicles: Government Requirements and Commercial Competition*, by Marcia Smith.

transfer $40 million from the HSF account to the Mars 2003 Lander program. According to the conference report, the transferred funds are to come from shuttle reserves and the commercialization and technology program.

The FY2001 authorization act authorized $3.166 billion for Space Shuttle operations and safety and performance upgrades for FY2001, the NASA request.

The major concerns about NASA's space shuttle operations center on shuttle safety. Since 1998, the Aerospace Advisory Panel's annual reports have expressed concern about future shuttle safety. In particular the reports note that personnel issues such as a growing shortage of skilled workers and aging of the shuttle workforce coupled with budget constraints and downsizing might lead to serious safety problems. On March 9, 2000, NASA released a report of an independent review it had commissioned of shuttle systems and maintenance.[7] The review expressed high regard for the dedication and skill of the shuttle workforce. At the same time the report presented nine issues providing broad guidance to NASA in managing shuttle operations and maintenance. In addition, the report noted a number of technical problems that needed addressing and provided NASA with 81 recommendations about steps to take between now and 2006 to improve shuttle safety and reliability. Four of these were highlighted for action prior to the next flight. NASA appears to be addressing these concerns with its FY2001 appropriation and an FY2000 supplemental appropriation to shift funds to hire more shuttle personnel and do additional upgrades. Because the shuttle is likely to be the primary means of human access to space for several more years, continued efforts to maintain safe shuttle operations are essential.

The 106th Congress, in the FY2001 appropriations act conference report, affirmed earlier congressional concern about NASA's failure to fly dedicated life and microgravity research missions on the shuttle during construction of the ISS. Accordingly, the 106th Congress directed NASA to submit a plan to the Appropriations Committees within 30 days of the enactment of the FY2001 appropriations bill giving a detailed schedule of such flights beginning after flight STS-107.

Payload and ELV Support. The Payload and ELV Support program is charged with support and processing of shuttle payloads and of NASA payloads that use expendable launch vehicles (ELV). Included are the technical expertise and facilities for payload buildup, test and checkout, integration, servicing, transportation, and installation in the shuttle prior to launch. In addition to funding for all NASA missions requiring ELVs, the activity provides advanced mission design and analysis, and integration services for future missions considering an ELV launch vehicle.

For FY2001, NASA requested $90.2 million for this program compared to $79.9 million approved for the comparable activities in FY2000. For FY2001, the program is supporting 20 major and secondary payloads for the shuttle including hardware for

---

[7] NASA, Space Shuttle Independent Assessment Team, *Report to the Associate Administrator; Office of Space Flight: October-December 1999,* "The MacDonald Report" March 7, 2000 [http://www.nasa.gov/newsinfo/publicreports.html].

the ISS. For the ELV portion, the program is supporting 11 missions and one secondary payload.

The FY2001 NASA appropriations act provides the amount requested for this program for FY2001. In the FY2001 authorization act, $90.2 million was authorized for this program.

Investments and Support. For FY2001, NASA proposed to separate the engineering and technical base (ETB) activity from payload and ELV support. In addition, NASA included in the Investment and Support program rocket propulsion test support, technology and commercialization activities, and additional funding for academic programs. The ETB activity provides technical support for NASA's space flight laboratories and test beds.

For FY2001, this program requested $129.5 million, including $73.5 million for the ETB activity. The latter is $11.7 million below that approved for ETB in FY2000. The Investments and Support program will be the home of the Human Exploration and Development of Space Technology and Commercialization initiative in FY2001. This initiative is designed to foster innovative technology for future human exploration of space and enable commercial development of such technologies. For FY2001, the NASA Space Flight Centers is being converted to full cost accounting and all ETB activities and budgets will be assigned to specific customers resulting in the phasing out of a specific ETB budget. Also in FY2001, NASA's rocket propulsion test capabilities are being consolidated to ensure effective management and maintenance. Important facility upgrades are also planned for FY2001 along with investments in new technology for testing.

In the FY2001 appropriations act, the requested amount was provided for this program for FY2001. In the FY2001 NASA authorization act, $129.5 million was authorized for this program.

Science, Aeronautics, and Technology

The Science, Aeronautics, and Technology account of the NASA budget funds the bulk of its research and development activities. Included are the Offices of Space Science, Earth Science, Life and Microgravity Science and Applications, Aero-Space Technology, Space Operations, and Academic Programs. The Offices of Space and Earth Science focus on increasing human understanding of space and the planet, and make use of satellites, space probes, and robotic space craft to gather and transmit data. The Office of Life and Microgravity Science and Applications funds research in biological areas important for human exploration of space. The Office of Aero-Space Technology supports aeronautics research that continues a long tradition dating back to NASA's predecessors, the National Advisory Committee on Aeronautics. It also funds advanced space transportation R&D aimed at lowering the cost of access to space. Space Operations is a new program for FY2001, combining the activities of the current Mission Communications Services and Space Communications Services. The new program will be responsible for communications activities of all of NASA's space missions.

The FY2001 NASA appropriations act provides $6.191 billion for SAT, 4.4% above the request and 10.9% above the FY2000 level. Included in the total approved for SAT are funds to meet NASA's original SAT request plus $46 million in net increases for the Mars 2003 Lander program subsequently requested by NASA. In addition, the total includes $264.3 million in funding for projects and activities specifically identified and directed by the 106th Congress. Finally, the 106th Congress approved a general reduction of $49 million for SAT. That reduction has not yet been allocated to the programs making up the SAT account. The FY2001 NASA authorization act authorized $6.078 billion for this account.

Space Science. The Office of Space Science (OSS), which is responsible for NASA's Space Science Enterprise, has four missions: understanding the universe, exploration of the solar system, discovering planets around other stars, and searching for life beyond Earth. Using primarily space-based telescopes and other sensing probes, the NASA OSS programs study the nature of stellar objects to determine their formation, evolution, and fate. Robotic probes are sent to other bodies in the solar system, searching for information about their makeup and whether the conditions for life exist. To accomplish these tasks, NASA supports a number of activities: a series of large, focused missions such as the Space Infrared Telescope Facility (SIRTF) and the Hubble Space Telescope (HST); the Explorer program to provide low-cost access to space with small, single purpose satellites; the Discovery program to support small planetary missions; and a Mars exploration activity. The OSS also funds an extensive supporting research and technology (SR&T) effort. The research component focuses on data analysis and theoretical studies to understand space-based observations, and supports complementary ground-based and laboratory activities. Universities and NASA centers are the principal performers of supporting research. The supporting technology component of the SR&T program is designed to provide enabling technologies for the next generation of space science missions, cross-cutting technology development that can be used on a number of NASA missions, and flight testing of new technologies that can be used on future NASA science missions.

Through its Supporting Research and Technology program, the NASA OSS is putting more emphasis on developing enabling technology for future missions. By expending more effort at this stage, NASA hopes to reduce the cost and increase the reliability of its future missions. A principal example of this technique is the Next Generation Space Telescope (NGST) currently in the planning stage. NASA has set stringent cost requirements for the project even though its goal is to perform more extensive science than the Hubble Space Telescope. About 30% of the NGST's cost will be for enabling technology development.

For FY2001, NASA requested $2.399 billion for the OSS, an increase of $206 million above the amount approved for FY2000. Included in the FY2001 request were $168.1 million for HST development, $117.6 million for the SIRTF, $138.8 million for Explorer development, $326.7 million for the Mars Surveyor Program, $196.6 million for the Discovery program, $1.30 billion for SR&T, and $13.2 million for education.[8] For FY2001, NASA is continuing work on Servicing Mission 4 for

[8] These two subprograms are located within Academic programs. For FY2001, NASA, (continued...)

the HST, now scheduled for June 2003.[9] Three missions are planned for launch under the Explorer program in FY2001, along with continued development of several others scheduled for launch in FY2002 through FY2004. For the Discovery program, launch is planned for the Genesis mission, designed to return charged particles from the solar wind to Earth. In addition, startup of a new activity, Discovery Micromissions, is underway which focuses on ways to carry out inexpensive solar system science. NASA recently completed a review of the Mars program and announced a new plan for the program.[10] The first mission, schedule for launch in April 2001, will be the 2001 Mars Odyssey and orbiting spacecraft designed to explore the structure of the planet.[11] Other missions include twin Mars Exploration Rovers planned for launch in 2003 and a scientific orbiter planned for 2005.[12]

For FY2001, NASA is focusing on activities in four areas of the technology portion of the Supporting Research and Technology program for FY2001. These are technology, including the Next Generation Space Telescope, for the astronomical search for origins; technology for advanced deep space systems including the Europa orbiter and the Pluto/Kuiper Express mission; technology for study of the structure and evolution of the universe; and technology for the Sun-Earth Connections program. The last element includes the Living With a Star initiative that will focus on understanding the origin of solar disturbances and how they affect human-made space and terrestrial technology.[13] For this initiative, which is projected to cost about $433 million from FY2001 to FY2005, NASA requested $20 million for FY2001. In addition, NASA requested an additional $5 million for FY2001 to expand research in nanotechnology as part of the Administration's National Nanotechnology Initiative. Within the research portion of SR&T, NASA is continuing to fund a broad range of space science data analysis and basic research to understand observations from

---

[8](...continued)
for the first time, has assigned the portions funded by the OSS and OES to those offices.

[9] Service mission 3B is now scheduled to take place no earlier than June 2001, and may slip into FY2001.

[10] National Aeronautics and Space Administration, *Mars Program Independent Assessment Team Report*, March 14, 2000. http://www.nasa.gov/newsinfo/mpiat_summary.pdf

[11] NASA Press Release , 00-071, ftp://ftp.hq.nasa.gov/pub/pao/pressrel/2000/00-171.txt Oct. 26, 2000.

[12] NASA Press Release, 00-155, ftp://ftp.hq.nasa.gov/pub/pao/pressrel/2000/00-155.txt September 28, 2000.

[13] Solar variability describes changes in the sun's burning activity over time. Those changes can be rather violent — solar storms — and result in significant variation in solar radiation and eruptions from the Sun's surface that can send a stream of energetic electrons to the Earth. When these electrons strike the Earth's magnetic field, significant disruptions can occur — geomagnetic storms — that can interfere with radio communications and long-range radar, and disrupt electric power transmission. In addition, the energetic particles can damage sensitive electronics in space systems and may be a threat to human space activity.

various space science missions. In addition, a series of high-priority studies in the Astrobiology Institute[14] are being funded and 25 sounding rockets will be launched.

The FY2001 NASA appropriations act provides $2.508 billion, 4.6% above the original request and 14.4% above the FY2000 level. Included is $75 million for the Mars 2003 Lander that was requested by NASA subsequent to the original budget request. If this is added to the original request (a net of $73 million because $2 million is to come from other space science programs), the revised request is $2.472 billion. The act also provides the $20 million requested for the Living With a Star initiative. The 106th Congress also put a cost cap of $75 million on the Hubble Wide Field Camera 3 and directed NASA not to allocate costs of servicing the Hubble Space Telescope to the Human Space Flight account until the Appropriations Committees can review NASA's policy for such allocations. Finally, the 106th Congress approved $34.5 million for specifically identified projects.

The FY2001 NASA authorization act authorizes $2.418 billion. Of that amount, $523.6 million is authorized for the Research Program, and $12 million for space solar power technology.

The Space Science Enterprise has perhaps the most ambitious mission of any activity within NASA. Until recently, efforts toward fulfilling that mission made use primarily of costly, highly sophisticated and complex missions. NASA successes have been substantial, significantly advancing our understanding of the universe and our knowledge of the solar system. At the same time, those missions have had a history of cost overruns and schedule delays. In some cases, technical problems have developed that have cost NASA a great deal to fix, when a fix was possible. To continue towards its space and Earth science goals, NASA adopted a policy of "faster, better, cheaper"(FBC) in the early 1990s to guide the design of future space missions. This policy would not eliminate the risks just mentioned, but it was hoped that it would reduce the consequences of such risks. Those risks became quite visible last year with the consecutive loss of the two Mars missions mentioned above, following the loss of the Lewis and WIRE missions.[15] Since 1992, NASA has launched 16 robotic space exploration missions under its "faster, better, cheaper" policy and seven of them either failed or had serious technical problems post launch.[16] That record has raised concerns among some observers.

At the same time, the number of satellite and spacecraft launches, many of which fall under the FBC rubric, has increased dramatically. The cost of those 16 missions is still less than the single Cassini probe, which was the last robotic mission NASA launched under the old policy. In addition, the launch rate is much greater now than

---

[14] The Astrobiology Institute is a partnership between NASA and academic institutions to study the origin, evolution, distribution, and destiny of life in the universe.

[15] The Wide-field Infrared Explorer (WIRE) mission was designed to detect infrared radiation from certain types of galaxies. The Lewis and Clark missions were funded by the Office of Earth Science and were designed to demonstrate different land imaging capabilities. The Clark mission was cancelled because of cost overruns.

[16] Robert Lee Hotz, "Are Failed Mars Probes the Price of Cost-Cutting?" *Los Angeles Times,* December 26, 1999. [http://www.latimes.com/cgi-bin/print.cgi].

prior to 1992. Still, concerns remain about this policy. In particular, some believe that technical risk has increased too much even if the financial consequences of failures might be less. In particular, the emphasis on cost may be too great, leading to shortcuts taken by NASA and its contractors that increase the risk of failure for those missions to unacceptable levels. It is possible that the basic FBC policy is not flawed, and that a relatively small increase in funds for and time spent on each mission could reduce the failure rate. A recent review commissioned by NASA of the FBC policy also concluded that the problem lay in too much emphasis on cost and schedule reduction and not enough on oversight by NASA officials.[17]

A related concern is whether such missions are compromising the achievement of scientific goals. In other words, are there scientific issues that cannot be addressed using small, inexpensive satellites? In 1998, Congress requested that NASA contract with the National Research Council (NRC) to study this question. That study was recently completed and concluded that while the FBC mission policy was sound, its implementation too often "jeopardized the scientific objectives of these missions."[18] The NRC recommends that NASA should make sure that the driving force behind its missions be the desired scientific outcomes and not the mission cost. According to the study, while some missions can be performed with small, less costly spacecraft, others will require larger systems to achieve their scientific goals.

Another issue is concern about the value of the Living With a Star initiative. While requesting only a small amount of funds for FY2001 for the project, NASA estimates that annual project costs will grow to about $200 million annually (in FY2000 dollars) over the period FY2006 to FY2009 and then begin to decline. Total project cost through FY2010 would be about $1.7 billion. The project plan is quite complex, involving the launch of numerous satellites over the next several years, including one that will orbit the Sun and another that will be placed in a fixed position on the opposite side of the Sun from Earth. A primary goal of the project is to be able to predict the onset of potentially damaging solar eruptions with greater lead times than is possible now. NASA claims that the benefits could be substantial noting that the nation and the world are increasingly dependent on satellite systems that are vulnerable to solar disturbances. In addition, as human presence in space is expected to increase substantially with habitation of the ISS, dangers to that presence from solar activity are also likely to increase. As a result, the ability to avoid a significant amount of the potential damage from solar disturbances could be quite beneficial.

It is not clear, however, just how much the knowledge that might be gained from the Living With a Star program will allow any significant mitigation of that risk. Some believe that an increase of a few hours in warning time of the arrival of particles erupting from the Sun's surface will provide enough time to shut down vulnerable systems. Whether such actions would be sufficient to protect sophisticated electronics systems aboard satellites is not clear. Furthermore, the program is quite

---

[17] National Aeronautics and Space Administration, *NASA FBC Final Report*, March 14, 2000, [http://www.nasa.gov/newsinfo/publicreports.html]

[18] National Research Council, Space Studies Board, *Assessment of Mission Size Trade-offs for Earth and Space Science Missions,* March 14, 2000 [http://www.nap.edu/ catalog/9796.html].

costly and might result in a substantial reduction of resources available for other important space science projects over the next several years. In that context, NASA does not appear to have made it clear why its existing Sun-Earth Connections program would not be able to meet the goals of the new program.

In the conference report, the 106th Congress repeated the concern expressed in the Senate report about ensuring that at least 75% of all space science advanced technology funding be done competitively. It noted NASA's concern that increased competitive funding would result in the degradation of core competencies in the centers by diverting funds from those centers. To deal with this issue, the 106th Congress allowed that NASA could request reprogramming of funds from other "sources" to maintain those core competencies, and that these requests would be considered by the Appropriations Committees. It directed the Office of Aerospace Technology (see below) to provide the 107th Congress with an assessment of the core-competency concern. The 106th Congress also directed NASA to carry out an analysis of the cost implications of applying the recommendations of the Mars Program Independent Assessment Team to all space science programs. With respect to the Living With a Star initiative, the 106th Congress directed NASA to consider the recommendations of the NASA Inspector General, the Applied Physics Laboratory, and NASA about the procurement strategy for this program. It also adopted the Senate Appropriations Committee's recommendation that NASA prepare a long-term plan for the Sun-Earth Connection program.

In the conference report with the FY2001 NASA authorization act, the 106th Congress expressed their continued commitment to exploring Mars and the increase in the program's baseline funding requested over the FY2001 to FY2005 period. The 106th Congress also endorsed the "faster, better, cheaper" concept and expressed belief that it will do more to achieve space science goals than the older, large mission concept. At the same time, it urged NASA to provide a better definition of the concept to improve its implementation.

Life and Microgravity Sciences and Applications. The Office of Life and Microgravity Sciences and Applications (OLMSA) funds and directs biomedical and health research in support of the Human Exploration and Development of Space enterprise. It carries out a number of programs that investigate the biomedical effects of space flight and the effects of gravity on biological processes, develop technologies to support humans living in space, enhance space crew health and safety, and address medical care requirements for human space flight. The office also supports research on biological, chemical, and physical processes in a microgravity environment. An important function of OLMSA is to assist the private sector to make use of space for product development, primarily in the life sciences. Research activities sponsored by OLMSA are now carried out in space on robotic vehicles, in ground-based laboratories, and on space shuttle missions. The International Space Station is intended to serve as a site for OLMSA research beginning in FY2001.

For FY2001, NASA requested $304.4 million, up from $274.7 million approved for FY2000. Included in the request were $76.9 million for biomedical research and countermeasures, $39.2 million for fundamental biology research, and $129.26 million for microgravity research. NASA proposed a Bioastronautics initiative for FY2001 that would accelerate R&D on various means — diagnostics, preventatives, therapy, etc. — to maintain the health of humans on long-duration space flights. In FY2001, OLMSA is expanding research operations on the ISS and funding 164 separate investigations in the fundamental biology area. NASA is continuing preparation of the ISS for microgravity research and plans to carry out such research on suborbital missions and one shuttle flight during FY2001. In addition, in FY2001, OLMSA is funding research on biology-based technology that could support biological computing and materials research.

In the FY2001 NASA appropriations act, the 106th Congress approved funding of $316.9 million for the OLMSA, 4.8% above the request and 15.4% above the FY2000 level. Included in the appropriation is a reduction of $7 million for funds transferred to the Mars 2003 Lander program at NASA's request, and $24.5 million for projects specifically identified by the 106th Congress.

The enacted FY2001 NASA authorization act authorizes $335.2 million for the OLMSA. In addition the act specifies that $70 million of that amount is authorized for ISS-associated research.

In H.Rept. 106-145 accompanying its authorization bill, the House noted that the increases it approved are, in part, designed to help restore microgravity and life science research funding that NASA had removed to help pay for ISS cost increases. The report language noted that the restored funds were being placed under control of the OLMSA rather than in the ISS research budget in order to permit NASA to undo "the damage done to the research community" by the cuts. This language was reaffirmed by the 106th Congress in the conference report.

Earth Science. The Office of Earth Science (OES), which is responsible for NASA's Earth Science Enterprise (ESE), supports programs that focus on the effects of natural and human-induced changes on the global environment. The ESE is the largest federal agency program studying the Earth and its environment. The program aids scientific understanding of environmental issues, particularly global climate change. NASA uses a combination of space-based, airborne, and ground-based instruments to acquire long-term data on the Earth climate system. OES supports research and analysis programs that assist scientists in converting these data into knowledge of the Earth system. At the same time, OES operates a data and information management system to capture, process, archive, and distribute data to the scientific community and the public. A final cross-cutting objective of OES is the development of enabling remote sensing technologies, which can be used to reduce the cost and increase the reliability of future missions. A significant objective of OES is to enhance predictive capabilities about potential global environmental risks. In support of this objective, NASA is a significant contributor to the United States Global Change Research Program (USGCRP), the International Geosphere-Biosphere Program (IGBP), and the World Climate Research Program (WCRP).

There are three major program areas within OES. The centerpiece is the Earth Observing System (EOS) spacecraft series. The series consists of several polar-orbiting and low inclination satellites of various sizes, many of which include international contributions. The EOS program also supports research designed to analyze data and develop models that might explain the spacecrafts' observations. The first EOS satellite was launched in 1999, and launches will continue through

2003. OES is in the process of developing a science implementation plan that will drive the selection of follow-on missions to this first phase of EOS spacecraft. To process EOS flight data into useful information, NASA has also created an EOS Data Information System (EOSDIS). The agency characterizes EOSDIS as evolutionary, including the phased deployment of the EOS satellites and their enabling data transmission technology. Though significant technical difficulties delayed the deployment of the second and third versions of EOSDIS, the agency reports that both are now performing successfully. Also complimenting EOS is the Earth Probes program, which NASA defines as consisting of unique, specific, and highly-focused missions. This set of missions includes those opportunities presented by international cooperative efforts, small satellites, and advanced technologies. Earth Probes can investigate processes requiring special orbits or short development cycles of one to three years. One such Earth Probe project is Triana, a spacecraft that would be located at the Earth-Sun LaGrange-1 (L1) point, and which has been the subject of significant congressional controversy.[19]

For FY2001, NASA requested $1.406 billion for the Office of Earth Sciences, a decrease of 3.4% below the FY2000 appropriation. Of this amount, $819.5 million is for Major Developments, including $447.1 million for EOS, $252.0 million for EOSDIS, and $120.4 million for the Earth Probes program. NASA also requested $533.3 million for Research and Technology, including $353.2 million for Earth Science Program Science, $69.2 million for Applications, Commercialization and Education, and $110.9 million for Technology Infusion.[20] Finally, the agency requested $42.7 million for Operations, and $10.3 million for Investments, the latter of which includes $8.8 million for the Minority University Research and Education subprogram and $1.5 million for the Education subprogram.[21] OES plans to launch eight spacecraft in FY2001, including Triana and three EOS satellites.[22] OES expects that FY2001 will be a very important year for EOSDIS, especially given expected increases in the volume of archived climate data, and the demand for timely delivery

---

[19] The Earth-Sun L-1 (LaGrange-1) point is the location in space where the Earth's gravitation field just balances the Sun's gravitation field. A satellite placed at that point would remain stationary with respect to the Earth, allowing a continuous, full disk sunlit view of the Earth. For more information, see: CRS Report RS20252, *NASA's Triana Spacecraft: An Overview of Congressional Issues*, by Erin Hatch, March 29, 2000.

[20] According to NASA's FY2001 budget justification documents, the agency has restructured the FY2001 OES budget to display Research and Technology budgetary allotments in a manner more readily understood by NASA's customers. As a result, the former Research and Technology budget has been subdivided into three categories: Earth Science Program Science, Applications Commercialization and Education (ACE), and Technology Infusion. In addition, Technology Infusion allotments formerly contained within the EOS budget are now budgeted within Research and Technology. The agency contends that this restructured format aligns the Research and Technology budget requirements with the manner in which they are managed within the agency.

[21] See note 10.

[22] The three planned FY2001 EOS launches are JASON-1 (a follow-on mission to TOPEX/Poseidon), Aqua (formerly known as EOS PM-1), and IceSat (Ice, Clouds and Land Elevation Satellite).

of archived products. The next phase of EOSDIS deployment is scheduled for April 2001..

The FY2001 NASA appropriations act provides $1.498 billion for Earth Sciences, $92.3 million (6.6%) above the request and $5.5 million (3.8%) above the FY2000 level. Included in the total are an increase of $20 million to continue purchasing commercial remote sensing products and an increase of $35 million for EOSDIS development. Also included are an additional $37.3 million for projects specifically identified by the 106th Congress. The 106th Congress also expressed its concern about NASA's failure to implement congressional directives, and prohibited the reprogramming of any funds by the Office of Earth Science unless specifically authorized by the Appropriations Committees of the House and Senate.

The FY2001 NASA authorization act authorized $1.431 billion for FY2001, $25 million above the request. The 106th Congress retained authorization for the Triana project.

Substantial criticism of the Office of Earth Sciences over the last several years has resulted primarily from delays in the EOS program and the controversial nature of many of the subjects being studied by the EOS program (e.g., global climate change).[23] These issues have led some to question the value of NASA's Earth science program as a whole. Some EOS program delays are attributable to difficulties in developing data management and satellite control software for the EOSDIS program. NASA has been forced to scale back the program more than once from its original design. Agency officials now assert that the new EOSDIS time line is both incremental and realistic. In FY2002, some EOSDIS operations will become part of the Consolidated Space Operations Contract (see below), and the agency plans for EOSDIS to be fully operational by the end of FY2003. OES also has received criticism from the National Research Council regarding the lack of a "fully integrated science plan" for missions following completion of the first EOS series.[24] As a result, OES is in the process of developing a targeted research program—including a set of specific science questions—for missions in 2003 and beyond. Another area that was of interest to the 106th Congress and is likely to be an issue in the 107th Congress as well is the impact of OES missions on the emerging commercial remote sensing industry. Other possible issues that may hold over into the 107th Congress include: competitive pricing procedures for government remote sensing data; federal resolution restrictions on civilian data sets; government-mandated satellite imagery black-out zones ("shutter control"); consistency in data standards and licensing procedures, and guidelines for building satellites versus purchasing data from commercial providers.[25]

---

[23] For more information about these issues and other areas of congressional interest in NASA's Earth science programs, see CRS Report RS20673, *NASA's Earth Science Enterprise*, by Erin Hatch.

[24] National Research Council, Task Group on Assessment of NASA Plans for Post-2002 Earth Observing Missions, *NASA's Plans for Post-2002 Earth Observing Missions*, April 26, 1999, 4 [http://www.nas.edu/ssb/post2000menu.htm].

[25] Due to national security concerns, current law and administration policy allow U.S. companies to sell commercial satellite imagery data only at 1-meter or lower resolution. The (continued...)

In the conference report accompanying the FY2001 NASA appropriations act, the 106th Congress directed NASA to report to the House and Senate Appropriations Committees by March 15, 2001, with a ten-year strategy and funding profile to extend benefits from the enterprise's science, technology, and data results "beyond the traditional science community and address practical, near-term problems." NASA was further directed to work with other specific entities in making public and private remote sensing and related technologies available to state and local governments, and to public and private organizations. The 106th Congress expressed concern about a potential delay in launch for the Vegetation Canopy LIDAR Project (VCL), and requested NASA to report by October 2001 on the mission's development status.[26] The 106th Congress also recommended that NASA initiate studies for a commercial follow-on to the Landsat-7 mission, for minimizing costs on EOSDIS, to assist in developing the NPOESS Preparatory Project (NPP), and for other related technology development work.

In the conference report with the FY2001 NASA authorization act, the 106th Congress directed $25 million to be used by the Commercial Remote Sensing Program for commercial data purchases, unless NASA obligates at least 5% of the combined EOS and Earth Probes budgets for purchasing Earth science data from the private sector.

Aero-Space Technology. The Office of Aero-Space Technology, which is responsible for the Aero-Space Technology Enterprise, supports NASA's Aeronautical Research and Technology and Advanced Space Transportation Technology programs. The Office is divided into the Research and Technology Base and the Focused programs. For FY2001 NASA is proposing to integrate the aeronautics and space transportation activities of the Office. The Technology Base programs are responsible for developing new technologies, processes, and computational tools that can enhance development of new aero-space technologies. The programs support both the aeronautical and the space transportation activities of the Office. The programs that make up the Technology Base are information technology, intelligent synthesis environment, vehicle systems technology, propulsion

---

[25](...continued)
U.S. government also prohibits the sale of satellite imagery to rogue countries such as Iraq and North Korea. Furthermore, the U.S. government can prohibit a U.S. company from selling satellite images of a specific geographic area; this policy is known as "shutter control."

[26] The VCL mission is expected to provide a better understanding of the structure of Earth's forests, and the impact human land use has had on them. The mission was originally priced at $60 million, was scheduled to launch in September 2000. However, earlier in 2000, NASA officials stated that the project would require an extra $47 million to complete, and the mission would not be ready to launch until at least May 2002. In order to prevent the mission from being cancelled, a group of scientists have been trying to secure private financing for the project. In the mean time, NASA has agreed to continue funding VCL until December 2000. For more information, see: Brian Berger, "NASA Panel Extends VCL Mission Funding," *Space News*, August 14, 2000, p. 3; Brian Berger, "Scientists Seeks Corporate Investors for VCL Mission," *Space News*, August 7, 2000, p. 1; and the VCL website: http://essp.gsfc.nasa.gov/vcl.html.

and power technology, flight research, operations systems, rotorcraft, and space transfer and launch technology.

The Focused programs examine specific civilian aviation and space transportation technical issues through separate projects. The Focused programs include NASA's high-performance computing and communications effort, the aviation system capacity project, the aviation safety program, the ultra-efficient engine technology program, the future X-pathfinder project, the X-34 project, and the enabling space launch initiative.

A major goal of the Office of Aero-Space Technology is the development and demonstration of next-generation technology for access to space. Such technology could serve as the basis for commercial space transportation systems. Consequently, this work is often done in partnership with industry. The prime NASA goal is a dramatic reduction in launch costs, while improving reliability and safety. The final responsibility of the Office is NASA's Commercial Technology Programs. These programs included NASA's technology transfer activities and the Small Business Innovative Research Program.

For FY2001, NASA requested $1.193 billion for Aero-Space Technology, up from $1.125 billion approved for FY2000. Included in the request are $539.4 million for the Research and Technology Base programs and $507.4 million for the Focused programs. NASA proposed three initiatives for the Office for FY2001. The first is the small aircraft transportation system initiative to develop and demonstrate technologies permitting greater use of small, public-use airports. The purpose of the initiative is to allow those airports, most of which are under utilized, to make a greater contribution to improving the efficiency of the nation's transportation system. The second initiative, quiet aircraft technology, is aimed at achieving a dramatic reduction in airport noise. The third is the 2nd generation RLV program. Between now and 2005, NASA is planning to spend about $4.4 billion to develop the technology base for the shuttle replacement. It is NASA's hope that after this expenditure, the risk of developing a second generation RLV will be reduced to the point where the commercial sector will continue development toward an operating system to provide launch services to NASA and other potential customers. Included in the 2nd generation RLV initiative are programs to develop alternative access and 3rd generation RLV technology. The former is designed to support the use of existing and emerging commercial launch capabilities that could meet NASA requirements for access to the ISS. The latter program, which is now operating under the Spaceliner-100 designation, is focusing on technology that could make a substantial leap in cost reduction beyond more conventional RLV systems.

The FY2001 NASA appropriations act bill provides $1,253.2 million for the AST programs. Included in the total are a reduction of $20 million from the research and technology base for transfer to the Office of Space Science for the Mars 2003 Lander program as requested by NASA, the full $9 million requested for the SATS program, and the full $290 million requested for the 2nd generation RLV (space launch initiative (SLI)) program. The act also provides an additional $13 million for the ultra-efficient engine technology program. Finally, the total includes $67.2 million for projects specifically identified by the 106th Congress.

The FY2001 NASA authorization act authorized $1.193 billion for FY2001, the requested amount. While expressing concern about the continuing decline of aeronautics research funding, the Act directs that for FY2001, $36 million be for quiet aircraft technology programs, $70 million for aviation safety programs, and $50 million for ultra-efficient engine technology programs. The 106th Congress also endorsed the approach of the Space Launch initiative and authorized full funding for the 2nd Generation Reusable Launch Vehicle program.

The development of the next generation RLV has been under consideration at NASA for several years. The Agency has known for some time that a replacement to the shuttle would be necessary eventually, and that lowering the cost of access to space would be essential to continuing human exploration and development of space. The plan NASA has announced this year appears to take a new approach to that effort. While it includes the X-33, X-34 and Future-X programs, the main focus is on a new, competitive program to reduce the risk of RLV development. Indeed, NASA's contribution to those three "X" programs is expected to be completed by the end of FY2002. There are many unanswered questions about the new NASA approach, however, that may be raised during consideration of the request. It is not clear, for example, what role if any the three "X" programs will have in the risk reduction effort. Also, there are no assurances that at the end of the risk reduction program, the space-launch industry will feel confident that it can proceed with development of an operating launch system without additional NASA funds beyond those needed for NASA-unique requirements. Nevertheless, a new approach to next generation RLV development might be needed. The existing efforts, while making progress, do not seem to be offering a promising outcome. And NASA believes that it will need to replace the shuttle, as it is currently configured, within 10 to 12 years, although upgrades could make it last longer, perhaps to 2030 if necessary.

In the conference report with the FY2001 NASA appropriations act, the 106th Congress informed NASA that its funding of the SATS program was predicated on NASA using the funds to carry out assessment of four concepts that "promise to increase the safe and efficient capacity of the National Airspace System" and "extend reliable air service to smaller communities." In carrying out these assessments, NASA is to work closely with the Federal Aviation Administration who will be responsible for implementing those concepts that prove to be of value. The 106th Congress also directed that at least 75% of the funds awarded in the SATS program should be through a competitive process. Because the program may require additional resources in the future for successful completion, the 106th Congress directed NASA to include them in the FY2002 budget request. The 106th Congress also expressed its "general" agreement with the two principles stated in the Senate report about the Space Launch Initiative (SLI). It further directed NASA to ensure that at least 75% of the SLI funds be subject to a competitive process and that all NASA Centers be eligible. The 106th Congress also expressed its continued support of the Software Optimization and Reuse Technology (SORT) program and the transfer of program management to the Goddard Space Flight Center. Finally, the 106th Congress, noting that the Cross-Enterprise Technology Development Program (CETDP) has been transferred to the Office of Aerospace Technology, directed OAT to report on how it plans to increase the fraction of advanced technology funding subject to competitive selection while maintaining the core competencies of the NASA Centers (see above).

The Fy2001 NASA authorization act reaffirmed the support of the 106th Congress for a strong aeronautical R&D program. They also stated that NASA should modernize its aeronautical research facilities to keep pace with growing demands. The106th Congress also expressed their endorsement of NASA's approach and plan for the 2nd generation RLV initiative, particularly the emphasis on preserving competition among different concepts. Furthermore, the 106th Congress commended NASA on taking steps, through the space launch initiative's Alternative Access program, to reduce dependence on the Space Shuttle and the Russian Soyuz and Progress vehicles for access to the ISS. The 106th Congress noted that modernization of NASA's space launch infrastructure will likely be needed for the 2nd generation RLV program. The 106th Congress also noted that the authorization act directs NASA to develop a plan to integrate NASA's aeronautics and space transportation R&D activities. In particular, the 106th Congress is concerned about the lack of "strategic direction and adequate funding" for aeronautics research and point out the many benefits that have been derived from that research. It expressed hope that the integration efforts will lead to benefits for both aeronautics and space launch research programs, and the 106th Congress expect that the integration will help strengthen aeronautics research in the United States over the next decade.

Space Operations. The Space Operations program provides command, tracking, telemetry, and data services between ground facilities and all of NASA's missions. Satellite links, ground networks, mission control, data processing, and related facilities comprise the elements of this program. Services are provided for every NASA mission, including deep space probes, Earth-orbiting satellites, research aircraft, and sub-orbital flights. High-speed telecommunication links are provided to connect industry, university, and laboratory scientists participating in NASA missions with tracking, data acquisition, mission control, and data processing facilities. Mission support services and mission planning and analysis are also provided by the Space Operations program.

For the last few years, NASA has attempted to cut costs by contracting for communications and operations services, and consolidating these contracts. The largest example of this effort is the Consolidated Space Operations Contract (CSOC), which was awarded to Lockheed Martin Space Operations Company on September 25, 1998, and began operations on January 1, 1999. The agency asserts that when fully implemented, CSOC will provide end-to-end space operations mission and data services to both NASA and non-NASA customers.[27]

For Space Operations in FY2001, NASA requested $529.4 million, not including program office contributions, which is an increase of 6.7% over the FY2000 appropriation. Of this amount, $422.0 million is for Mission Communications Services (formerly contained in the Mission Support account), including $158.6 million for Ground Networks (e.g. the Deep Space Network), $254.6 million for Mission Control and Data Systems, and $8.8 million for Space Network Customer

---

[27] NASA's contract with Lockheed Martin allows for excess operations and communications capacity to be marketed and sold by the contractor, which would also keep any fees received.

Services. NASA also requested $107.4 million for Space Communications Services (formerly contained in the Science, Aeronautics, and Technology (SAT) account), including $4.8 million for Space Network Services, $55.0 million for the Tracking and Data Relay System (TDRS) Replacement Spacecraft and Launch Services, and $47.6 million for the NASA Integrated Services Network. Including contributions from other program offices, the total Space Operations FY2001 request was $672.2 million, $358.5 million for CSOC services and $314.2 million for non-CSOC services.[28]

In an attempt to streamline accounting and management processes, NASA recently reorganized its space operations and communications budgets. Previously, the NASA space operations effort was split between the Mission Communications Services program in the SAT account, and the Space Communications Services program in the Mission Support account. The Space Communications Services program operated the space-based portion of the network, while the Mission Communications Services program supported the ground-based portion. Beginning in FY2001, NASA's Space Operations effort is consolidated in the SAT account. NASA states that these two programs are to be combined so as to more directly link space communications activities with the programs that use these facilities and services. Moreover, the agency contends that this new budget configuration will enable more effective management of the Space Operations program as a whole.

The FY2001 NASA appropriations act provides $529.4 million for Space Operations (formerly Mission Communications Services) for FY2001. The FY2001 NASA authorization act, following NASA's new space Operations budget structure authorized the requested amount for Space Operations, $529.4 million.

NASA is continuing this reorganization trend by moving towards a "fee for service" accounting system for space operations services. The agency has already begun this transition by designing an on-line space operations and management catalog of all related services available to NASA missions. This catalog will eventually enable NASA programs to order standard space operations mission and data services. During FY2001, agency officials are identifying all operations costs for each NASA office.[29] This will allow offices, and potentially individual programs, to directly account for operations expenses. Eventually, perhaps as early as FY2003, the agency intends to budget for all space operations costs directly within the account for the program office receiving the services.

In 1999, NASA reported that anticipated cost savings from CSOC would be delayed because initial cost reductions due to management consolidation would be

---

[28] For CSOC, NASA's FY2001 request includes $215.2 million from Space Operations and a combined total of $143.3 million from four program offices.

[29] For example, NASA plans that all communications and operations costs of Office of Space Science's programs and projects will be assigned to that office rather than be assigned to Space Operations as is now the practice. The same would be done for the Office of Earth Sciences, the Office of Life and Microgravity Sciences and Applications, the Office of Space Flight, and the Office of Aero-Space Technology.

used for a new system architecture.[30] In addition, in anticipation of CSOC savings, some FY1999 funds for space operations and communications were shifted to other NASA programs; these funds were primarily transferred from the Space Communications program to the International Space Station (ISS) account. Along with other technical and management difficulties experienced by the contractor in implementing CSOC, these decreases in available funds have delayed full implementation of the system. NASA still expects to save $1.4 billion from CSOC over the ten years of the contract, but now says that the majority of these savings will be realized in the last five years. Challenges are anticipated in developing the appropriate CSOC capacity for the anticipated future demand. In addition, the agency expects to experience difficulties in increasing the outsourcing of operations and communications services, and in achieving the CSOC small business goals.[31]

In the conference report with the FY2001 NASA authorization act, the 106th Congress directed that no funds be used to create a government-owned corporation to perform CSOC functions.

Academic Programs. Academic programs include a broad array of activities designed to improve science education at all levels. They include programs that directly support student involvement in NASA research, train educators and faculty, develop new educational technologies, provide NASA resources and materials in support of educational curriculum development, and involve higher education resources and personnel in NASA research efforts. In addition, a separate set of programs is devoted to minority education issues. Academic programs supply NASA mission and research experience to students in grades K-12, and support for graduate students in NASA-related disciplines. Teachers at the K-12 level receive training from NASA to enhance math and science teaching skills and the application of NASA research results in the classroom. In both cases, efforts are made to reach underrepresented populations. Efforts to improve K-12 and higher education are supported through the Aerospace Education Services and National Space Grant College and Fellowship programs. NASA also funds an Experimental Program to Stimulate Competitive Research (EPSCoR) to help develop research capabilities of states that have been less successful in obtaining NASA research grants. Programs are also funded to develop new teaching technologies based on NASA developments, apply those technologies to the classroom, and involve educators in NASA missions.

Programs devoted to minority education focus on expanding participation of historically minority-dominant universities in NASA research efforts. Working with NASA enterprises, these programs develop opportunities for participation by researchers and students from those institutions in NASA activities. Five competitive, peer-reviewed research award categories have been set up for those institutions. The objectives are to improve research quality in those universities, and increase the number of underrepresented investigators supported by NASA.

---

[30] "Rohrabacher Worried CSOC Won't Produce Promised Savings," *Aerospace Daily*, March 15, 1999, p. 384.

[31] NASA's CSOC contract with Lockheed Martin and its industry partners includes a goal of procuring 25% of services from small businesses.

For FY2001, NASA requested $100 million for Academic programs, a reduction of $38 million from the amount approved for FY2000. The reduction was primarily due to NASA's decision not to continue funding programs mandated by the 106th Congress in the FY2000 appropriation, which amounted to $38 million. Included in the FY2001 request is $54.1 million for the Education subprogram and $45.9 million for the Minority Research and Education subprogram. In the latter, NASA is selecting, through merit review, additional Science, Engineering, Mathematics, and Aerospace Academies at minority institutions. NASA is also involving its Strategic Enterprises more fully in partnership awards with minority institutions, which will be run through the NASA Centers. Under the Education subprogram, NASA is continuing efforts at much the same level as in FY2000.

The FY2001 NASA appropriations act provides $134 million for Academic Programs. Included in the total are an increase of $5.4 million for the EPSCoR program (to total of $10 million) and an increase of $9.1 million for minority university research and education activities (to a total of $55 million). Also included in the total is an additional $20.5 million for projects specifically identified by the 106th Congress.

The FY2001 NASA authorization act authorizes $141.3 million, $41.3 million above the request. Of that amount, the act directs that $28 million be for Space Grant Colleges and $54 million for minority university research and education.

Mission Support

The Mission Support account provides funds for the principal support activities for NASA missions. It includes funding for NASA civil service employees, assurance of mission safety and quality, development of engineering policies and standards, and facility construction.

The FY2001 NASA appropriations act provides $2.609 billion for these programs.

Safety, Mission Assurance, Engineering, and Advanced Concepts. The Safety, Mission Assurance, Engineering, and Advanced Concepts (SMAEAC) budget has three components: the safety of NASA missions and personnel, oversight of NASA's crosscutting technology development activities, and coordination of NASA-wide technology goals. The Office of Safety and Mission Assurance (OSMA) sets agency-wide safety and mission assurance policy and strategy, sets standards, and oversees compliance. It also supports research on new methods to assure safe and successful missions. The Office of Chief Engineer (OCE) is responsible for development of policies and standards to enhance NASA engineering practices. The Office of the Chief Technologist (OCT) is responsible for development of a NASA-wide investment strategy for innovative technology, and oversight of NASA technology policies and capabilities.

For FY2001, NASA requested $47.5 million, up from $43 million approved for FY2000. The SMAEAC program supporting 8 shuttle and 11 expendable launch vehicle missions in FY2001. In addition, the NASA electronics program, which performs radiation testing and readiness assessments of advanced electronic packages, is developing new methods in FY2001 for qualifying technologies and assessing their readiness. Other activities are continuing at FY2000 levels.

The FY2001 NASA appropriations act provides $47.5 million for these activities, the requested amount. The FY2001 NASA authorization act authorized the same amount.

Research and Program Management. Research and program management provides the salaries, benefits, travel, and administrative support for all of NASA's civil service employees. It also provides all travel funds, and funds for facilities and technical services, and for management and operations supplies and equipment.

For FY2001, NASA requested $2.291 billion for research and program management, an increase of $73 million over that approved for FY2000. NASA plans to increase its workforce in FY2001 to a total full-time equivalent level of 18,741 from 18,413 at the end of FY2000. The increase is in response to concerns that NASA's downsizing effort, begun in FY1993, has resulted in staffing levels below that needed in mission critical and safety-related areas.

The FY2001 NASA appropriation act provides $2.287 billion. Included is a reduction of $6 million from the request and a transfer of those funds to the Mars 2003 Lander project as requested by NASA. The act also includes an additional $2.2 million to fund a two-year test of fractional ownership of administrative aircraft.

In the conference report with the FY2001 NASA authorization act, the 106^{th} Congress directed NASA to take steps to ensure a "robust and safe" aerospace program over the next several years. In particular, the 106^{th} Congress noted the high percentage of NASA employees eligible for retirement and the need to make sure NASA facilities are safe. It directed NASA to prepare a plan for ensuring the maintenance of critical management and technical skills throughout the agency and upgrading facilities and equipment to ensure safety.

Construction of Facilities. Construction of facilities provides funding for individual projects needed to maintain NASA's basic infrastructure and its institutional facilities.

For FY2001, NASA requested $245.9 million for this activity, an increase of $64 million above the amount approved for FY2000. The increase is a result of construction of several new utilities and support structures at various NASA Centers and an increase in minor revitalization and small facility construction projects at those Centers.

The FY2001 NASA appropriations act provides $274.4 million for construction of facilities, 11.6% above the request and 50.8% above the FY2000 level. Included in the total are increases of $18 million for the E-Complex and $10.5 million for the Propulsion Test Operations Building. The FY2001 NASA authorization act authorizes $245.9 million for FY2001, the requested amount.

Outyear Budget Projections

Along with its FY2001 budget request, NASA supplied estimates of its requests for the succeeding four years. That five-year budget outlook is provided in Table 2. Although the outyear estimates are subject to change, the trends they provide indicate the general directions that NASA is headed at this time. The table shows that NASA plans to increase spending for the next five years. Significant increases are projected in the Science, Aeronautics, and Technology account, slower growth is projected for the Mission Support account, and the Human Space Flight account is projected to decline. This outyear budget forecast is a substantial departure from the one presented with the FY2000 request, where NASA had projected that its total budget request would stay flat between FY2001 and FY2004. The outyear budget forecast accompanying the FY2001 request projected a FY2004 budget that is 11.3% higher than the one projected in last year's NASA budget justification.[32]

Table 3. NASA FY2001 and Outyear Budget Estimate

Category	FY2001	FY2002	FY2003	FY2004	FY2005
Human Space Flight	5,499.9	5,347.8	4,939.0	4,817.4	4,686.3
Science, Aero, and Tech	5,929.4	6,388.9	6,993.9	7,571.3	7,913.5
Mission Support	2,584.0	2,666.2	2,812.7	2,892.2	2,945.1
Inspector General	22.0	22.7	23.6	24.5	25.4
Total	**14.035.3**	**14,465.3**	**14,769.2**	**15,305.4**	**15,570.3**

Source: NASA *FY2000 Budget Estimate*

For the Human Space Flight account, funding for the ISS is projected to decline by nearly 40% between FY2001 and FY2005 as the station is completed. In addition, NASA plans to transfer work on the Crew Return Vehicle to the Office of Aero-Space Technology, further reducing outyear ISS funding requirements. Funding for the shuttle is projected to remain relatively flat over that period. Funding would peak in FY2002 as a result of the safety and supportability upgrades scheduled over the next five years.

NASA proposes that funding for the Office of Space Science would grow by about 45% between FY2001 and FY2005. The growth is to be focused in the Supporting Research and Technology (SR&T) programs, primarily the Astronomical Search for Origins and the Sun-Earth Connection programs. The latter includes the Living With a Star initiative. A modest increase in funding for the SR&T core program is projected. Increases are also projected for the Explorer Development and

[32] See CRS Report RL30154, *The National Aeronautics and Space Administration's FY2000 Budget: Description and Analysis*, by Richard Rowberg.

Discovery programs. Included in the Explorer Development program is an outyear wedge of $110 million reserved for future projects to sustain a presence in exploration of the solar system. Funding for the Hubble Space Telescope is projected to decline sharply as the telescope nears the end of its useful life.

Increased funding is also projected for the Office of Aero-Space Technology. NASA is proposing a 93% increase in funding for the Office between FY2001 and FY2005. All of the increase would be for the 2nd Generation RLV initiative. Funding for that initiative is projected to grow by 360% over FY2001–FY2005. The Aero-Space Base and Focused programs would remain essentially flat for that period.

Funding for the Office of Life and Microgravity Science and Applications and the Office of Earth Sciences would change little during the FY2001–FY2005 time period. The former would grow slightly, in part to accommodate outyear funding for the Bioastronautics Initiative. Funding for the Office of Earth Sciences is projected to decline about 7% over that period. Funding for the Research and Technology programs would grow while funding of the Earth Observing System would decline as the system's satellites are deployed. Funding for Space Operations is projected to decline by about 43% as savings from the CSOC consolidation begin to emerge.

Both the House and Senate authorization bills provide amounts for FY2002 as shown in Table 2. As was the case for FY2001, many of the amounts authorized are well below those NASA plans to request for FY2002, although they are greater for the ISS and Earth Sciences. The latter reflects the turndown of spending requirements for the ISS and EOS that were not conveyed in the FY2000 request, while the former represents new initiatives approved with the FY2001 appropriations. As seen in Table 2, those changes are reflected in the FY2002 authorization levels reported in the conference report.