National Aeronautics and
Space Administration

II. Supplementary Information

Supplementary Information

Overview

This Supplementary Information Volume provides additional information on the major projects in formulation or development phases as identified in the budget request and is organized by Directorates and Themes.

The formulation phase includes all activities prior to a formal commitment by the Agency to proceed into full development. This commitment is granted only after development of independent cost estimates, completion of a non-advocacy review, establishment of a life-cycle cost baseline, and the signing of a formal Program Commitment Agreement. This step usually occurs after completion of the preliminary design review.

The development phase includes design, development, testing, and evaluation, and commences with the signing of the Program Commitment Agreement, and completes with launch or delivery of the product. During the development phase, a project must meet specific technical requirements and substantiate its life-cycle cost projections.

Each project section provides an Overview section describing the scope and objectives of the project and gives a broad picture of what the project will accomplish and its benefits. The organization responsible for project management is listed in the Program Management section. The Technical Description section provides project details, including how the project objectives will be accomplished. This section also includes a description of all the elements of the project and a summary of work being performed in these elements. The Schedule section includes key project milestones with dates and any changes from the FY 2005 plan. The section on Strategy for Major Planned Acquisitions lists future major acquisitions, including planned announcements and acquisition goals (e.g., full and open competition, directed work, or partnerships). The Risk Management section lists key known risks and strategies to mitigate these risks. The Budget section provides only the FY 2006 request for projects in formulation that do not yet have an established life cycle baseline, or the entire life-cycle cost baseline for all development projects.

Under full cost, NASA allocates all costs to its programs, including general and administrative (G&A) costs from the Centers and the Agency (corporate G&A). The project costs shown in this Supplementary Information Volume include all direct costs, but only the G&A costs from the Centers performing the work. Corporate G&A is not allocated to the projects in these reports. Since corporate allocations are solely based upon total program costs, project manager decisions are not influenced by allocation of corporate overhead. For each of these projects, the allocation by year of corporate overhead can easily be calculated.

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Theme:	Solar System Exploration
Program:	Discovery
Project In Development:	Dawn

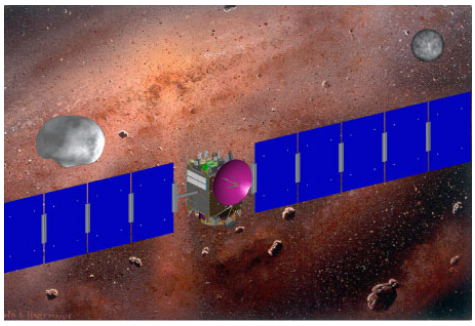
President's FY 2006 Budget Request

(Dollars in Millions)

Dawn	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010
FY 2006 PRES BUD	126.5	78.2	49.2	6.2	5.7	5.9	7.0
Changes from FY 2005 Request	1.6	-6.2	5.4	0.1	-0.7	-0.8	

Overview

The Dawn mission's primary objective is to significantly increase our understanding of the conditions and processes present during the solar system's earliest history by investigating in detail two of the largest protoplanets remaining intact since their formation. Specifically, the spacecraft will examine the geophysical and geochemical properties of 1 Ceres and 4 Vesta; main belt asteroids that reside between Mars and Jupiter. This will be accomplished by sending a spacecraft to orbit these asteroids and perform science investigations using imaging, spectroscopy, and gravity measurements.



An artist's rendition of Dawn with Vesta and Ceres.

Currently in development phase: Life-Cycle-Cost (LCC) data provided and NASA is committed to the LCC estimate.

The Dawn Homepage can be accessed at:
http://dawn.jpl.nasa.gov

Changes From FY 2005

- The laser altimeter and magnetometer instruments were deleted, and a one month launch delay (from May 2006 to June 2006) in order to fit the mission within its cost cap and funding profile.
- Vesta Encounter reduced from 11 months to 7 months, and Ceres Encounter reduced from 11months to 5 months.

Program Management

The JPL is responsible for Dawn project management.

Technical Description

Dawn has a focused set of science and measurement objectives to be obtained through radio science and three instruments. The mission launches in June 2006 and uses solar-electric propulsion to reach and orbit Vesta (for seven months) and Ceres for (five months), while performing science investigations at various altitudes and lighting conditions. The use of solar-electric propulsion readily mitigates launch injection errors and is used during the interplanetary cruise to match trajectories with the asteroid. Dawn uses a maximum of one ion thruster operating at a time (there are three thrusters on the spacecraft). Stay times at Vesta and Ceres can easily be extended. The total mission duration is nine years.

Theme:	Solar System Exploration
Program:	Discovery
Project In Development:	Dawn

Schedule

Date	Key Milestones	Change From FY 2005
9/2002	Start of Formulation	None
10/2003	Preliminary Design Review	None
5/2004	Mission Critical Design Review	None
6/2006	Launch	Slip one month (from May 2006)
10/2011	Vesta Encounter	None
8/2015	Ceres Encounter	None
8/2016	End of Mission	None

Strategy For Major Planned Acquisitions

- All major acquisitions are in place.

Key Participants

- The German Aerospace Center (DLR) provides the framing camera instrument.
- JPL is responsible for project management and mission operations.
- The Italian Space Agency (ASI) is responsible for the Mapping Spectrometer.
- Los Alamos National Labs is providing the GRAND instrument.

Budget Detail/Life Cycle Cost (Dollars in Millions)

Budget Authority	Prior	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010	BTC	Total	Comments
FY 2006 PRES BUD	37.8	126.5	78.2	49.2	6.2	5.7	5.9	7.0	47.3	363.8	
Changes	0.0	1.6	-6.2	5.4	0.1	-0.7	-0.8		-9.0	-2.6	
FY2005 President's Budget	37.8	124.9	84.4	43.8	6.1	6.4	6.7		56.3	366.4	

Additional funding to for resolving technical and schedule problems.

Theme:	Solar System Exploration
Program:	New Frontiers
Project In Development:	New Horizons

President's FY 2006 Budget Request

(Dollars in Millions)

New Horizons	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010
FY 2006 PRES BUD	140.1	103.0	87.7	16.1	9.5	5.7	6.1
Changes from FY 2005 Request	23.3	-12.8	3.3	-2.9	1.1	-0.2	

Overview

The New Horizons Pluto mission will conduct a reconnaissance of the Pluto-Charon system and potentially the Kuiper Belt. The mission objectives are to: a) Characterize the global geology and morphology of Pluto and Charon; b) Map the surface composition of Pluto and Charon; and c) Characterize the neutral atmosphere of Pluto and its escape rate.

New Horizons will seek to answer key scientific questions regarding the surfaces, atmospheres, interiors, and space environments of Pluto and Charon using imaging, visible and infrared spectral mapping, ultraviolet spectroscopy, radio science, and in-situ plasma sensors.

The New Horizons Homepage can be accessed at: http://pluto.jhuapl.edu/mission.htm

New Horizons spacecraft and payload in deep space - artist's conception.

Changes From FY 2005

- None.

Program Management

The Applied Physics Laboratory is responsible for New Horizons project management.

Technical Description

New Horizons is scheduled to launch aboard an Atlas V launch vehicle in January 2006, swing past Jupiter for a gravity boost and scientific studies in February 2007, and reach Pluto and its moon, Charon, in July 2015. The spacecraft may then head deeper into the Kuiper Belt to study one or more of the icy mini-worlds in that vast region that lies at least a billion miles beyond Neptune's orbit.

Theme:	Solar System Exploration
Program:	New Frontiers
Project In Development:	New Horizons

Schedule

Date	Key Milestones	Change From FY 2005
6/2001	Approved for Formulation	None
3/2003	Approved for Implementation	None
10/2003	Critical Design Review	None
1/2006	Launch	None
3/2007	Jupiter Flyby / Gravity Assist	None
7/ 2015	Pluto-Charon Encounter	None
2017-2020	Kepler Belt Object Encounters	None

Strategy For Major Planned Acquisitions

- All major acquisitions are in place.

Key Participants

- Principal Investigator is at Southwest Research Institute.
- Johns Hopkins University/Applied Physics Laboratory has project management responsibility.

Risk Management

- RISK: Nuclear launch approval process and schedule, launch vehicle certification schedule, observatory delivery schedule, and overall project cost issue. MITIGATION: NASA Headquarters has chartered the Discovery and New Frontiers Program office at the MSFC to perform an Independent Assessment of the New Horizon's mission with respect to the following: 1)Assess the mission's readiness to support a January 2006 launch date; 2)Assess the Project's ability to deliver the Spacecraft and Instruments that meet the AO based contractual requirements.

Budget Detail/Life Cycle Cost (Dollars in Millions)

Budget Authority	Prior	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010	BTC	Total	Comments
FY 2006 PRES BUD	154.3	140.1	103.0	87.7	16.1	9.5	5.7	6.1	72.4	594.9	
Changes	0.0	23.3	-12.8	3.3	-2.9	1.1	-0.2		-42.2	-24.3	
FY2005 President's Budget	154.3	116.8	115.8	84.4	19.0	8.4	5.9		114.6	619.2	

Additional funding to cover launch vehicle cost growth.

Theme:	Solar System Exploration
Program:	Mars Exploration
Project In Development:	Mars Reconnaissance Orbiter 2005 (MRO)

President's FY 2006 Budget Request

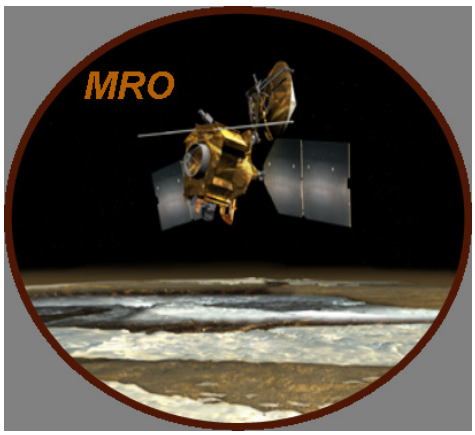
(Dollars in Millions)

Mars Reconnaissance Orbiter 2005 (MRO)	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010
FY 2006 PRES BUD	195.3	102.7	45.5	44.0	37.2	22.9	21.6
Changes from FY 2005 Request	12.9	-7.2	-0.9	-3.6	-1.7	-1.0	

Overview

The Mars Reconnaissance Orbiter (MRO) mission objective is to understand the history of water on Mars by observing the planet's atmosphere, surface, and subsurface in unprecedented detail. This mission will identify the best sites for a new generation of landed vehicles to explore, by virtue of its ability to find local evidence of the chemical and geological "fingerprints" of water and other critical processes. MRO will explore from orbit hundreds of locations on the surface of Mars, observing details that were previously only visible to landers. MRO will focus on locations identified as most promising by Mars Global Surveyor and Odyssey, searching for the presence of surface materials conducive to biological activity or having the potential for preserving biogenic materials.

The MRO website can be accessed at:
http://mars.jpl.nasa.gov/missions/future/2005-plus.html



MRO Payload and Spacecraft - artist's conception orbiting MARS.

Changes From FY 2005

- None.

Program Management

The JPL is responsible for this segment of the Mars Exploration Program.

Technical Description

The MRO will be launched in August 2005 by an intermediate-class expendable launch vehicle from Cape Canaveral Air Station, and will enter Mars orbit in 2006. The MRO mission will use its science payload and engineering systems to acquire global mapping, regional survey, and globally distributed targeted observations from a low-altitude, near-polar, mid-afternoon (dayside) Mars primary science orbit (PSO). Currently, the goal is to achieve a near-polar 255x320 km PSO with closest approach to Mars over the planet's south pole. The MRO will observe the planet's surface and atmosphere and explore its upper crust from the PSO during a primary science phase, lasting one Martian year (687 Earth days).

Theme:	Solar System Exploration
Program:	Mars Exploration
Project In Development:	Mars Reconnaissance Orbiter 2005 (MRO)

Schedule

Date	Key Milestones	Change From FY 2005
3rd Qtr FY05	Ship to Cape	
4th QTR FY05	Launch	None
FY06 - 4th QTR	MARS Orbit Insertion	None
4th QTR FY08	Primary Science Phase	None
4th QTR FY2010	Relay Phase	None

Strategy For Major Planned Acquisitions

- All Major Acquisitions are in place.

Key Participants

- Lockheed Martin Aerospace - Spacecraft and System Integrator
- BATC - HIRISE Instrument
  Applied Physics Lab. - CRISM Instrument
- The Agenzia Spaziale Italiana (ASI) - Shallow Radar Radar

Risk Management

- RISK: Additional problems uncovered during environmental testing will put significant pressure on the limited schedule reserve remaining. MITIGATION: Special risk and work-to-go review conducted; increased program-level monitoring of progress, risk tracking and schedule reserve status; evaluating efficiencies in launch site flow.

Budget Detail/Life Cycle Cost (Dollars in Millions)

Budget Authority	Prior	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010	BTC	Total	Comments
FY 2006 PRES BUD	216.9	195.3	102.7	45.5	44.0	37.2	22.9	21.6		686.0	
Changes	0.0	12.9	-7.2	-0.9	-3.6	-1.7	-1.0		-11.8	8.3	
FY2005 President's Budget	216.9	182.4	109.9	46.4	47.6	38.9	23.9		11.8	677.8	

Additional funding to for resolving technical and schedule problems to meet the August 2005 launch date.

Theme:	Solar System Exploration
Program:	Mars Exploration
Project In Formulation:	Phoenix (Scout 07)

President's FY 2006 Budget Request

(Dollars in Millions)

Phoenix (Scout 07)	FY2004	FY2005	FY2006
FY 2006 PRES BUD	25.4	96.1	94.4
Changes from FY 2005 Request	-3.5	-6.7	

Overview

The Mars Phoenix overall mission is to uncover clues to the geologic history and biological potential of the Martian arctic. Phoenix will be the first mission to return data from either polar region, providing an important contribution to the Mars science strategy of "follow the water."

While providing investigator-led flexibility to the Mars Program and allowing for reduced total mission life-cycle costs and development time, this project will also enhance public awareness of, and appreciation for, Mars exploration. Educational and public outreach activities are being incorporated as integral parts of Mars science investigations.

The Phoenix mission is the first in a series of smaller, lower-cost, completed spacecraft with the goal of a mission launch approximately every four years. Named for the resilient mythological bird, Phoenix uses a lander that was intended for use by 2001's Mars Surveyor lander prior to its cancellation. It also carries a complex suite of instruments that are improved variations of those that flew on the lost Mars Polar Lander.

Phoenix payload and spacecraft on MARS - artist's conception.

For more information on the Phoenix mission, visit: http://phoenix.lpl.arizona.edu

Changes From FY 2005

- None.

Program Management

Phoenix is a Principal Investigator-led Project. Program management responsibility has been delegated to JPL.

Technical Description

In the continuing pursuit of water on Mars, the poles are a good place to probe, as water ice is found there. Phoenix will land on the icy northern pole of Mars between 65 and 75-north latitude. During the course of the 150 Martian day mission, Phoenix will deploy its robotic arm and dig trenches up to half a meter (1.6 feet) into the layers of water ice. These layers, thought to be affected by seasonal climate changes, could contain organic compounds that are necessary for life. To analyze soil samples collected by the robotic arm, Phoenix will carry an "oven" and a "portable laboratory." Selected samples will be heated to release volatiles that can be examined for their chemical composition and other characteristics.

Theme:	Solar System Exploration
Program:	Mars Exploration
Project In Formulation:	Phoenix (Scout 07)

Schedule

Date	Key Milestones	Change From FY 2005
Feb 2005	Phoenix Preliminary Design Review	
March 2005	Phoenix Confirmation Review	
August 2005	Phoenix Critical Design Review	
Aug, 2007	Launch Date	
2008/2009	Orbit Insertion / End of Mission	

Strategy For Major Planned Acquisitions

- All major acquisitions are already in place

Key Participants

- Principal Investigator - University of Arizona, Lunar and Planetary Laboratory
- Lockheed Martin Aerospace - spacecraft provider

Theme:	Solar System Exploration
Program:	Mars Exploration
Project In Formulation:	2009 Mars Science Laboratory

President's FY 2006 Budget Request

(Dollars in Millions)

2009 Mars Science Laboratory	FY2004	FY2005	FY2006
FY 2006 PRES BUD	111.7	162.3	183.9
Changes from FY 2005 Request	-5.6	-12.3	

Overview

The 2009 Mars Science Laboratory (MSL) will be a long-duration, roving science laboratory that will be provide a major leap in surface measurement technology focusing on Mars habitability. Detailed measurements will be made of element composition, elemental isotopes and abundance, mineralogy, and organic compounds to determine if Mars has, or ever had, an environment capable of supporting life. The project will develop critical technologies for Entry, Descent, and Landing (EDL), long-life systems, autonomous operations, sample acquisition, handling and processing, and Mars proximity telecommunications.

MSL Rover on Mars - artist's conception.

Some of the key attributes of the 2009 MSL mission include: 12 months of flight time; five to six course corrections; direct entry with altimetry performed in terminal descent; a 450-600 kg rover; 2 earth years lifetime; 10 kilometer mobility.

The MSL Website can be accessed at: http://marsprogram.jpl.nasa.gov/missions/future/msl.html

Changes From FY 2005

- None.

Program Management

2009 MSL is a hybrid JPL-Science Community Mission with all major instrument acquisitions in place.

Technical Description

MSL is planned for launch in the September-October 2009 time frame, and will arrive at Mars in August 2010. The EDL system will be designed to accommodate a wide range of possible latitude and altitude locations on Mars in order to be discovery-responsive and to have the capability to reach very promising but difficult-to-reach scientific sites.

Theme:	Solar System Exploration
Program:	Mars Exploration
Project In Formulation:	2009 Mars Science Laboratory

Schedule

Date	Key Milestones	Change From FY 2005
4th Qtr 05	Initial Confirmation Review	
4th Qtr 06	Confirmation Review	
3rd Qtr 07	Critical Design Review	
10/2009	Launch	
2012	End of Mission	

Strategy For Major Planned Acquisitions

- 2009 Mars Science Laboratory - Hybrid JPL in-house and industry.
- All other major acquisitions are in place.

Key Participants

- Goddard Space Flight Center - Primary Analytical Chemistry Instrument - Sample Analysis at Mars (SAM).
- Honeybee Robotics - Robotic Arm Tools
- Malin Space Systems - Cameras

Theme:	Solar System Exploration
Program:	Mars Exploration
Project In Formulation:	2009 Mars Telecommunications Orbiter

President's FY 2006 Budget Request

(Dollars in Millions)

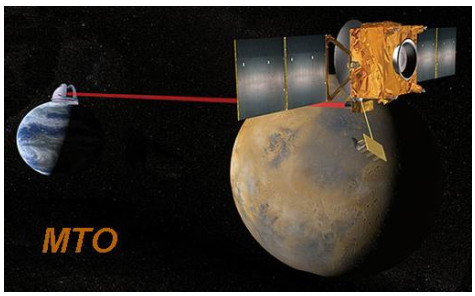
2009 Mars Telecommunications Orbiter	FY2004	FY2005	FY2006
FY 2006 PRES BUD	10.1	24.2	55.5
Changes from FY 2005 Request	0.9	-0.9	

Overview

Mars Telecommunications Orbiter(MTO) will be Mars' first high-speed data connection. The spacecraft will orbit Mars at a higher altitude than most orbiters and provide enhanced data relay for surface missions such as the Mars Science Laboratory.

The spacecraft will communicate with Earth via two radio bands and a new optical communications terminal, which will demonstrate the use of a laser beam for interplanetary communications.

Key attributes of the 2009 U.S. Telecom Orbiter mission: 1-year cruise; 10 years on orbit; Electra UHF and X-band link and gimbled camera. Communications relay for MSL, Scouts, MSR, and Next Decade Mars Surface and orbital Missions. Provide critical event coverage such as Entry Descent Landing (EDL), Mission Orbit Insertion (MOI), or Mars Ascent Vehicle (MAV). Demonstrate deep space laser comm from Mars detect and rendezvous with Orbiting Sample Canister. Demonstrate next generation autonomous navigation.



MTO Payload and Spacecraft orbiting Mars - artist's conception.

Changes From FY 2005

- None.

Program Management

GSFC is responsible for the Optical Communication Payload.

Technical Description

The 2009 MTO will serve as the Mars hub for a growing interplanetary internet. It will use three radio bands (X, Ka, UHF) and will be located at an optimal orbit to maximize coverage of orbital, sub-orbital, and surface assets on Mars. This capability will magnify the benefits of other future Mars missions and enable some types of missions otherwise impractical. The telesat will also include an operational demonstration of optical telecommunications technologies, which will significantly increase the communication data rate and improve the cost per byte of data returned. The Optical Communication Technology Demonstration will be led by the GSFC with the JPL and MIT Lincoln Lab as partners.

Theme:	Solar System Exploration
Program:	Mars Exploration
Project In Formulation:	2009 Mars Telecommunications Orbiter

Schedule

Date	Key Milestones	Change From FY 2005
3rd QTR CY 2005	MTO Mission & Systems Requirements Review (PreMSR)	
2nd QTR CY 05 / 06	2009MTO/MLCD PDR-2nd QTR CY05 CDR-2nd QTR CY06	
2nd QTR CY06/2nd QTR CY07	2009 MTO PDR -2nd QTR CY06; CDR-2nd QTR CY07	
2nd QTR CY08	2009 MTO/MLCD Shipment Review	
2nd QTR CY08	2009 MTO Assembly Readiness Review	

Strategy For Major Planned Acquisitions

- Spacecraft contractor acquisition is in progress.

Key Participants

- Massachusetts Institute of Technology (MIT) /Lincoln laboratories - Optical Communications Package

Theme:	Solar System Exploration
Program:	Robotic Lunar Exploration
Project In Formulation:	Lunar Reconnaissance Orbiter (LRO)

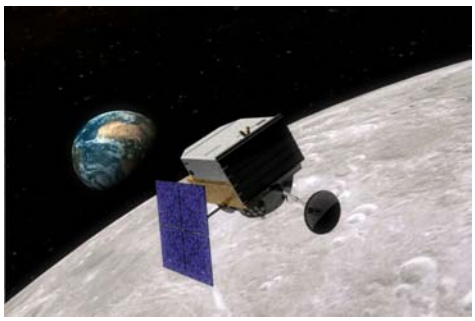
President's FY 2006 Budget Request

(Dollars in Millions)

Lunar Reconnaissance Orbiter (LRO)	FY2004	FY2005	FY2006
FY 2006 PRES BUD	17.0	40.2	105.0
Changes from FY 2005 Request	17.0	40.2	

Overview

Lunar reconnaissance Orbiter (LRO) is the first of the Lunar missions. It is planned for launch by late Fall 2008 and will orbit the Moon nominally for one year. The LRO mission emphasizes the objective of advancing Lunar Science and obtaining data that will facilitate returning humans safely to the Moon where testing and preparations for an eventual crewed mission to Mars will be undertaken. Launch of LRO in 2008 is necessary to meet the President's mandate to put humans on the moon between 2015 and 2020.



Lunar Reconnaisance Orbiter (LRO) spacecraft and payload - Conceptual Design.

The following objectives have been defined as having the highest priority to land humans on the moon between 2015-2020:

* Characterization of deep space radiation environment in Lunar orbit;
* Geodetic global topography;
* High spatial resolution hydrogen mapping;
* Temperature mapping in polar shadowed regions;
* Imaging of surface in permanently shadowed regions;
* Identification of putative deposits of appreciable near-surface water ice in polar cold traps;
* Assessment of meter and smaller scale features for landing sites; and
* Characterization of polar region lighting environment.

The LRO website can be accessed at: http://lunar.gsfc.nasa.gov/

Changes From FY 2005

- Lunar Reconnaisance Orbiter is a new project in formulation.

Program Management

The Robotic Lunar Exploration Program (RLEP) is delegated to the Goddard Space Flight Center (GSFC). Theme responsibility resides at SMD/NASA HQ.

Theme:	Solar System Exploration
Program:	Robotic Lunar Exploration
Project In Formulation:	Lunar Reconnaissance Orbiter (LRO)

Technical Description

The LRO mission will be launched from the NASA Kennedy Space Center Eastern Test Range, on an intermediate-class (e.g., Delta II) launch vehicle with a launch period opening and closing as early as October 2008. Payload instruments will be in a power-off state during the launch and injection phase. The cruise phase begins when the spacecraft separates from the launch vehicle and ends prior to Lunar orbit injection (LOI). The cruise phase lasts approximately a couple days, depending on the launch date, trajectory, and specific orbit selection.

After achieving the final mapping orbit, the LRO baseline mission is nominally one Earth year at a 30-50 kilometer circular, polar orbit. This may be followed by an extended mission of up to five years in a low maintenance orbit.

Schedule

Date	Key Milestones	Change From FY 2005
5/2005	Mission 2 Announcement of Opportunity Release	
6/2005	LRO Preliminary Design Review	
10/2005	Mission 2 Selection	
12/2005	LRO Confirmation Review	

Strategy For Major Planned Acquisitions

- The measurement investigations for the LRO were selected through the competitive AO Process.
- Spacecraft - TBD pending RFP release and selection.

Key Participants

- Instruments selections dependent upon Announcement of Opportunity (AO) down-selection.

Theme:	The Universe
Program:	Navigator
Project In Development:	Keck

President's FY 2006 Budget Request (Dollars in Millions)

Keck	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010
FY 2006 PRES BUD	13.2	11.3	10.4	12.6	13.0	15.4	17.0
Changes from FY 2005 Request	13.2	11.3	10.4	12.6	13.0	15.4	

Overview

The Keck Interferometer (KI) seeks to answer two basic questions: "Where do we come from?" and "Are we alone?" Key to answering these questions is finding out how galaxies, stars and planets form, and whether planets other than Earth have the conditions necessary to support life. To that end, Keck will address six science objectives:

Keck Observatory

1. MEASURE "EXOZODIACAL" LIGHT AROUND NEARBY STARS: Using a technique called nulling, cancel light from stars to examine the thermal emission from surrounding dust.

2. STUDY "HOT JUPITERS": Characterize atmospheres of hot, Jupiter-mass planets orbiting within 20 million kilometers of their parent stars.

3. FIND PLANETS AROUND NEARBY STARS: Using a technique called astrometry, look for wobble in a star's motion caused by the gravitational influence of an orbiting planet.

4. LOOK FOR NEWBORN STARS: Make images of stars as they emerge from clouds of gas and dust in which they form, and view the disks of gas and dust debris left over after stars have been created, where planets may be forming.

5. VIEW THE FAINTEST AND FARTHEST: Provide detailed information and images of some faint, dim, and distant objects far beyond the Milkyway galaxy.

6. SEE OUR SOLAR SYSTEM FAMILY UP CLOSE: Make very detailed observations of objects within our solar system, including asteroids, comets, and distant outer planets.

NASA has proposed adding 4-6 Outrigger Telescopes to the Keck Interferometer to accomplish objectives 3-6, but a final decision as to where to locate the Outriggers is pending the completion of the National Environmental Policy Act process.

For more information, please see:
http://planetquest.jpl.nasa.gov/Keck/keck_intr

Theme:	The Universe
Program:	Navigator
Project In Development:	Keck

Changes From FY 2005

- Nuller is scheduled to become operational in January 2006.
- Nuller Key Project (studying the dust around nearby stars that might be targets for the Terrestrial Planet Finder mission) observations start in early 2006.

Program Management

JPL is responsible for Keck Interferometer project management. NASA and JPL Program Management Councils have program oversight responsibility.

Technical Description

KI uses a technique called interferometry to achieve its objectives. Interferometry combines the light from two or more separate telescopes. The image has similar sharpness to that produced by a single telescope whose diameter is as large as the distance between the separate telescopes. The technique also allows measurement of motions of celestial bodies - in this case a star's tiny wobble due to an orbiting planet (Obj 3). This tiny wobble, equivalent to the width of a candy bar on the Moon as seen from Earth, can be measured using just the Outriggers. Obtaining ultra-sharp images (Obj 4-6) requires a large telescope as well, in this case the twin Keck 10-meter telescopes. Objectives 1 and 2 can be accomplished using only the twin Keck telescopes joined as an interferometer.

Schedule

Date	Key Milestones	Change From FY 2005
April 2001	"First light" joining twin telescopes (Keck-Keck)	None
April 2004	Keck-Keck available for general observing	None
January 2005	First nulling of star through Keck-Keck	N/A
January 2006	Nulling mode available for key project observing	N/A
September 2006	Differential Phase mode available	N/A

Strategy For Major Planned Acquisitions

- Major acquisitions are already in place.

Key Participants

- CalTech manages the project, provides technical expertise in interferometry, and develops key hardware and software components. The University of Hawaii holds the lease for the Mauna Kea Science Reserve.
- W.M. Keck Observatory, California Association for Research in Astronomy (CARA) operates the twin Keck 10-meter telescopes, the world's largest. The Keck Observatory manages the subcontract to fabricate the Outrigger Telescopes and will operate the interferometer on Mauna Kea.
- EOS Technologies, Inc., specializes in fabricating telescopes of modest size and is developing the Outrigger Telescopes. Their parent company, EOS, is developing the telescope domes and enclosures.
- SAIC and Tetra Tech support NASA in the Environmental Impact Statement process.

Theme:	The Universe
Program:	Navigator
Project In Development:	Keck

Budget Detail/Life Cycle Cost (Dollars in Millions)

Budget Authority	Prior	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010	BTC	Total	Comments
FY 2006 PRES BUD	71.1	13.2	11.3	10.4	12.6	13.0	15.4	17.0		163.9	
Changes	71.1	13.2	11.3	10.4	12.6	13.0	15.4			163.9	
FY2005 President's Budget											

Theme:	The Universe
Program:	Navigator
Project In Formulation:	Space Interferometry Mission (SIM)

President's FY 2006 Budget Request

(Dollars in Millions)

Space Interferometry Mission (SIM)	FY2004	FY2005	FY2006
FY 2006 PRES BUD	87.9	145.3	109.0
Changes from FY 2005 Request	16.5	-9.8	

Overview

Are planetary systems like this solar system common in the universe? In NASA's search for Earth-like planets, the question of where to look is key. Within the Navigator program, the Space Interferometry Mission is charged with the critical task of carrying out a planet census of potential targets for subsequent TPF missions. SIM provides the only method for unambiguously measuring mass, which determines a planet's ability to retain atmosphere long enough to make it possible to harbor.

How large is the universe? How old? What is dark matter and where is it found? In addition to searching for terrestrial planets, the SIM astrophysics program will address a host of other important questions as it maps the structure of this galaxy as well as those nearby.

SIM technology development is nearly complete, with only one of eight milestones remaining before the project is ready for implementation.

Artist's impression of SIM

For more information, please see:
http://planetquest.jpl.nasa.gov/SIM/sim_index.html

Changes From FY 2005

- Launch has slipped approximately two years.
- Cost increases on the SIM instrument and spacecraft have occurred as the design concept has matured and as the project moves toward implementation (when a cost cap is established).

Program Management

JPL is responsible for SIM project management. NASA and JPL Program Management Councils have program oversight responsibility.

Technical Description

SIM is designed as a space-based 10-meter baseline interferometer operating in the visible wavelength. Launched on an evolved expendible launch vehicle, SIM will enter an Earth-trailing solar orbit to carry out a 5-year operational mission with a 10-year goal.

Theme:	The Universe
Program:	Navigator
Project In Formulation:	Space Interferometry Mission (SIM)

Schedule

Date	Key Milestones	Change From FY 2005
	Schedule is under review.	N/A

Strategy For Major Planned Acquisitions

- Members of the SIM science team selected through an Announcement of Opportunity. Other government agencies and universities are included in this team.
- A competitive Requst For Proposal was issued for spacecraft, Assembly, Test and Launch Operations (ATLO), and operations support and Northrop Grumman Space Technology (NGST) was selected.

Key Participants

- U.S. Naval Observatory: SIM Science Team member with Memorandum Of Understanding for collaboration and exchange of data sets.
- Universities: SIM science team.
- Northrop Grumman Space Technology: spacecraft, ATLO, and operations support.

Theme:	The Universe
Program:	James Webb Space Telescope
Project In Formulation:	James Webb Space Telescope

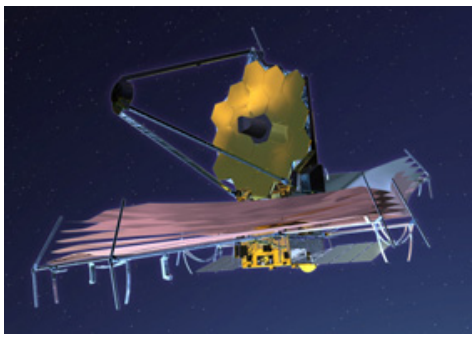
President's FY 2006 Budget Request

(Dollars in Millions)

James Webb Space Telescope	FY2004	FY2005	FY2006
FY 2006 PRES BUD	243.2	295.3	351.6
Changes from FY 2005 Request	-9.9	-22.8	

Overview

The James Webb Space Telescope (JWST)--identified by the National Research Council as a top priority for astronomy and physics for the decade--is a large deployable infrared astronomical space-based observatory. JWST will enter development in 2006 and is scheduled for launch in 2011. The mission is a logical successor to the Hubble Space Telescope (HST), extending Hubble's discoveries into the infrared, where the highly red-shifted early universe can be observed, where cool objects like protostars and protoplanetary disks emit strongly, and where dust obscures shorter wavelengths.



Artist's impression of JWST

During its five-year science mission, JWST will address the questions: "How did we get here?" and "Are we alone?" by exploring the mysterious epoch when the first luminous objects in the universe came into being after the Big Bang. Focus of scientific study will include first light, assembly of galaxies, origins of stars and planetary systems, and origins of life.

For more information, please see: http://www.jwst.nasa.gov/

Changes From FY 2005

- None.

Program Management

GSFC is responsible for JWST project management. NASA and GSFC Program Management Councils have program oversight responsibility.

Technical Description

In order to provide the resolution and sensitivity required by science investigations, JWST's main optic is 6.5 meters in diameter, and the telescope assembly and scientific instruments must operate at minus 365°Fahrenheit. A tennis court-sized shield shades these components from the Sun, Earth and Moon, allowing them to radiate their heat to the extreme temperatures of deep space and thus become very cold themselves. Since the telescope's main optic and the sunshade are too large to fit into the nose cone of any practical rocket, they must be folded up for launch. Once in space, they will unfurl into their operational configuration. JWST will orbit the Sun in tandem with Earth, around the Sun-Earth Lagrange point 2 (L2), which is ideally-suited for the observatory's mission.

Theme:	The Universe
Program:	James Webb Space Telescope
Project In Formulation:	James Webb Space Telescope

Schedule

Date	Key Milestones	Change From FY 2005
May 2006	Enter Development (begin Phase C/D)	None
December 2006	Mission Critical Design Review	None
September 2009	Mission Operations Review	None
August 2011	Launch	None

Strategy For Major Planned Acquisitions

- JWST is being built by Northrop Grumman Space Technology, teamed with Ball, Kodak and Alliant Techsystems. Selections were made via a NASA Request for Proposal.
- The Space Telescope Science Institute (STScI) is developing the Science and Operations Center and associated services. STScI was selected by the NASA Administrator.
- The University of Arizona, Tucson, is providing the primary near-infrared science camera. The selection was made via a NASA Announcement of Opportunity.

Key Participants

- The European Space Agency is providing science instrumentation--the near-infrared spectrograph and the optical bench assembly for the mid-infrared instrument (MIRI)--as well as operations support. A launch vehicle and launch services has also been proposed.
- The Canadian Space Agency is providing the fine guidance sensor for guiding the pointing of the telescope, as well as operations support.

Theme:	The Universe
Program:	Stratospheric Observatory for Infrared Astronomy (SOFIA)
Project In Development:	Stratospheric Observatory for Infrared Astronomy (SOFIA)

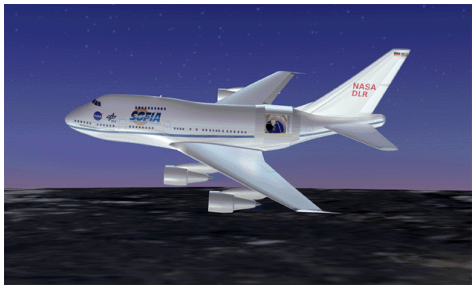
President's FY 2006 Budget Request

(Dollars in Millions)

Stratospheric Observatory for Infrared Astronomy (SOFIA)	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010
FY 2006 PRES BUD	66.9	48.3	45.7	54.1	56.1	57.0	57.2
Changes from FY 2005 Request	12.5	-4.2	-2.5	-2.7	-2.7	-2.8	

Overview

SOFIA is an astronomical observatory consisting of a 2.5-meter aperture telescope permanently installed in a specially modified Boeing 747 aircraft. The aircraft, with its open-port telescope, provided through a partnership with the German Aerospace Center (DLR), will provide routine access to nearly all of the visual, infrared, far-infrared, and sub-millimeter parts of the spectrum. It will operate from Moffett Federal Airfield in northern California, as well as from deployment sites in the Southern Hemisphere and elsewhere, as dictated by its astronomical targets. SOFIA will serve as a training ground for the next generations of instrument builders well into the 21st century, while producing new instrumentation important to NASA's future space observatories. SOFIA will have an active education and public outreach program, which will include flying educators as well as astronomers.



Artist's concept of SOFIA in flight with cavity door open and telescope visible.

The SOFIA program extends the range of astrophysical observations significantly beyond those of previous infrared airborne observatories through increases in sensitivity and angular resolution. SOFIA will be used to study many different kinds of astronomical objects and phenomena, including: star birth and death; solar system formation; complex molecules in space; planets, comets, and asteroids in the solar system; nebulae and dust in galaxies; and black holes at the centers of galaxies. Project is in development, therefore has baselined a life cycle cost commitment.

For more information, please see: http://sofia.arc.nasa.gov/

Changes From FY 2005

- NASA rather than Universities Space Research Association (USRA) will directly manage the aircraft maintenance and operations.

Program Management

ARC is responsible for SOFIA project management, including mission and science operations. NASA and ARC PMCs have program oversight responsibility.

Theme:	The Universe
Program:	Stratospheric Observatory for Infrared Astronomy (SOFIA)
Project In Development:	Stratospheric Observatory for Infrared Astronomy (SOFIA)

Technical Description

The SOFIA observatory is a highly-modified 747SP aircraft with a large open-port cavity aft of the wings, housing a 2.5-meter telescope optimized for infrared/sub-millimeter wavelength astronomy. The SOFIA Science and Mission Operations Center houses facility-class science instruments, principal investigator labs, data archives, science/mission planning systems, the main hangar, and supporting equipment to provide operations at a sustained rate of ~160 flights (960 science hours) per year. Additional science instruments provided under NASA grants are housed at separate institutions.

Schedule

Date	Key Milestones	Change From FY 2005
August 2006	Observatory performance testing complete.	12 months
August 2006	Operational Readiness Review	12 months
September 2006	First Science Flight/Beginning Science Operations	12 months
March 2006	Complete Airworthiness Flight Testing	

Strategy For Major Planned Acquisitions

- DLR is providing telescope assembly and support during science operations.
- A call for proposals will be issued annually for observing time.
- Competitions to procure new instruments will be conducted as needed.

Key Participants

- DLR is providing telescope assembly and support during operations in exchange for 20 percent of science observation time.
- Universities Space Research Association (USRA) is serving as prime contractor for aircraft modifications, ops center, and the first five years of operations.
- L3 Communications is USRA's major sub-contractor for aircraft modifications.

Risk Management

- RISK: Although unlikely, an aircraft accident could occur. MITIGATION: This risk has been mitigated by adherence to NASA's stringent airworthiness and safety standards and processes, while also requiring Federal Aviation Administration (FAA) certification in the development of the modified SOFIA aircraft.
- RISK: Observatory performance could fail to meet requirements due to worse than expected cavity environment. The likelihood of this occurring is low to moderate. MITIGATION: For the various aspects of performance (i.e.telescope pointing and image quality) that could affect SOFIA once it is conducting science operations, potential corrective measures have been analyzed. Specific mitigation techniques would be applied following characterizations during the flight test phase and early science operations if performance is inadequate.

Theme:	The Universe
Program:	Stratospheric Observatory for Infrared Astronomy (SOFIA)
Project In Development:	Stratospheric Observatory for Infrared Astronomy (SOFIA)

Budget Detail/Life Cycle Cost (Dollars in Millions)

Budget Authority	Prior	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010	BTC	Total	Comments
FY 2006 PRES BUD	318.0	66.9	48.3	45.7	54.1	56.1	57.0	57.2		703.3	
Changes	0.0	12.5	-4.2	-2.5	-2.7	-2.7	-2.8			54.8	
FY2005 President's Budget	318.0	54.4	52.5	48.2	56.8	58.8	59.8			648.5	

Theme:	The Universe
Program:	Gamma-ray Large Area Space Telescope (GLAST)
Project In Development:	Gamma-ray Large Area Space Telescope (GLAST)

President's FY 2006 Budget Request

(Dollars in Millions)

Gamma-ray Large Area Space Telescope (GLAST)	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010
FY 2006 PRES BUD	102.7	101.4	94.1	63.2	22.6	18.3	24.4
Changes from FY 2005 Request	-12.3	-1.8	-6.6	-0.4	-26.8	-6.0	

Overview

A collaboration with the Department of Energy, France, Italy, Sweden, Japan and Germany, the Gamma-ray Large Area Space Telescope (GLAST) will improve researchers' understanding of the structure of the universe, from its earliest beginnings to its ultimate fate. By measuring the direction, energy, and arrival time of celestial high-energy gamma rays, GLAST will map the sky with 50 times the sensitivity of previous missions, with corresponding improvements in resolution and coverage. Yielding new insights into the sources of high-energy cosmic gamma rays, GLAST will reveal the nature of astrophysical jets and relativistic flows and study the sources of gamma-ray bursts.

Artist's impression of GLAST

GLAST will also provide a new tool for studying how black holes, notorious for pulling matter in, can accelerate jets of gas outward at fantastic speeds. Physicists will be able to observe the effects of subatomic particles at energies far greater than those seen in ground-based particle accelerators and will also gain insights into the puzzling question of how energetic gamma rays are produced in the magnetosphere of spinning neutron stars. Perhaps the biggest return will come from understanding the nature of the high-energy gamma-ray sources that have escaped correlation at other wavelengths and constitute the unidentified bulk of nearly 300 known high-energy sources.

For more information, please see http://glast.gsfc.nasa.gov/

Changes From FY 2005

- Mission Critical Design Review was delayed due to the rebaseline of the Large Area Telescope (LAT) and withdrawal of international partners.

Program Management

GSFC - project management, including mission and science operations.
NASA and GSFC Program Management Councils - program responsibility.

Technical Description

The primary instrument on GLAST is the LAT, which will collect high-energy cosmic gamma rays with a 50-fold improvement in sensitivity over previous missions. During its planned primary mission of five years in Earth orbit, the telescope will both scan the sky and point at individual objects. The secondary instrument is the GLAST Gamma Ray Burst Monitor (GBM), which will detect gamma-ray bursts and immediately send their locations to the ground to alert astronomers to make follow-up observations. Like the LAT, the GBM also has better sensitivity and spatial resolution than its predecessors.

Theme:	The Universe
Program:	Gamma-ray Large Area Space Telescope (GLAST)
Project In Development:	Gamma-ray Large Area Space Telescope (GLAST)

Schedule

Date	Key Milestones	Change From FY 2005
June 2003	Preliminary Design Review	None
December 2003	Non-Advocate Review	None
September 2004	Mission Critical Design Review	Delayed 7 months
May 2007	Launch	None

Strategy For Major Planned Acquisitions

- The Science Support Center at GSFC will support guest observers (GO) and manage annual solicitation for GOs. Mission Ops Center personnel at GSFC will be provided by contractor set aside procurement.
- Spacecraft contractor is General Dynamics/Spectrum Astro, acquired via a blanket procurment through GSFC's Rapid Spacecraft Development Office.
- The primary instrument (LAT) at Stanford University and the secondary instrument (GBM) at MSFC were selected through an Announcement of Opportunity competitive selection in 2000.

Key Participants

- The Naval Research Laboratory, which assembles the Calorimeter for the LAT, environmentally tests the integrated instrument and provides science support.
- Stanford University is the home institution of the principal investigator of the LAT, and is also providing science support.
- Italy is responsible for assembly of the LAT tracker towers, which form the track imaging system, as well as additional hardware used in the towers. Japan and Italy are providing a portion of LAT silicon strip detectors and science support; France is also providing science support.
- Large Area Telescope development and instrument integration is managed by the Stanford Linear Accelerator Center, a Department of Energy funded laboratory located at Stanford University.

Risk Management

- RISK: LAT production delays are highly likely due to fabrication and test problems, and delayed vendor orders, as well as contractual issues involving international partners. Significant production delays may affect the observatory Integration and Test (I&T) and launch schedule. MITIGATION: NASA is closely monitoring progress in production, and looking at potential modifications to LAT environmental test and observatory I&T flows to mitigate the impact to launch from further tracker production delays.

Budget Detail/Life Cycle Cost (Dollars in Millions)

Budget Authority	Prior	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010	BTC	Total	Comments
FY 2006 PRES BUD	103.1	102.7	101.4	94.1	63.2	22.6	18.3	24.4		529.9	
Changes	0.0	-12.3	-1.8	-6.6	-0.4	-26.8	-6.0		-192.6	-222.0	
FY2005 President's Budget	103.1	115.0	103.2	100.7	63.6	49.4	24.3		192.6	751.9	

Theme:	The Universe
Program:	Discovery
Project In Formulation:	Kepler

President's FY 2006 Budget Request

(Dollars in Millions)

Kepler	FY2004	FY2005	FY2006
FY 2006 PRES BUD	50.8	118.9	111.5
Changes from FY 2005 Request	0.0	-8.3	

Overview

The centuries-old search for other Earth-like worlds has been rejuvenated by the intense excitement and popular interest surrounding the discovery of giant planets like Jupiter orbiting stars beyond our solar system. With the exception of the pulsar planets, all of the extrasolar planets detected so far are gas giants. The challenge now is to find terrestrial planets that are 30 to 600 times less massive than Jupiter. The Kepler mission is specifically designed to survey the extended solar neighborhood to detect and characterize hundreds of terrestrial and larger planets. Transits by terrestrial planets produce a fractional change in stellar brightness lasting 2 to 16 hours. The orbit and size of the planets can be calculated from the period and depth of the transit. From measurements of the period, change in brightness and known stellar type, the planetary size, orbital size and characteristic temperature are determined. From this the question of whether or not the planet is habitable (not necessarily inhabited) can be answered. The Kepler mission's specific objectives include: (1) determine the frequency of terrestrial and larger planets in or near the habitable zones of a wide variety of spectral types of stars; (2) determine the distribution of planet sizes and their orbital semi-major axes (half the longest diameter of the orbit); (3) estimate the frequency and orbital distribution of planets in multiple-stellar systems; and (4) determine the distributions of semi-major axis, albedo, size, mass, and density of short-period giant planets.

Currently in formulation phase; there is no LCC commitment.

For more information please see http://www.kepler.arc.nasa.gov

Changes From FY 2005

- Launch date being reassessed due to schedule concerns.

Program Management

JPL is responsible for Kepler project management, and Ames Research Center provides the principal investigator.

Theme:	The Universe
Program:	Discovery
Project In Formulation:	Kepler

Technical Description

The Kepler instrument is a 0.95-meter aperture differential photometer with a 105-degree squared field of view. The spacecraft will be launched into an Earth-trailing, heliocentric orbit. Following a 30-day characterization period, Kepler begins acquiring its scientific data by continuously and simultaneously observing over 100,000 target stars. During the first year, terrestrial planets with orbital periods shorter than that of Mercury -- as well as a wide range of larger planets with similar periods -- should be detected. Finally, the anticipated identification of Earth-size planets in the habitable zones of other star systems will begin during the third year. Mission lifetime is four years.

Schedule

Date	Key Milestones	Change From FY 2005
12/2001	Started Formulation	None
10/2004	Preliminary Design Review	none
4/2005	Approval for Implementation	Slip from December 2004
TBD	Critical Design Review	Change from 8/05
TBD	Launch	Change from 10/07
TBD	Mission completion	Change from 9/2012

Strategy For Major Planned Acquisitions

- All major acquisitions are in place.

Key Participants

- Ames Research Center, principle investigator, Instrument and Ground System Procurement
- The Jet Propulsion Laboratory, Program Management, Systems engineering, and Spacecraft Procurement
- Ball Aerospace and Technology Corporation, Instrument and Spacecraft development, test, and delivery.
- Laboratory for Atmospheric and Space Physics (LASP) at University of Colorado in Boulder is responsible for Mission Operations.

Theme:	The Universe
Program:	Explorer
Project In Formulation:	Wide-field Infrared Survey Explorer (WISE)

President's FY 2006 Budget Request

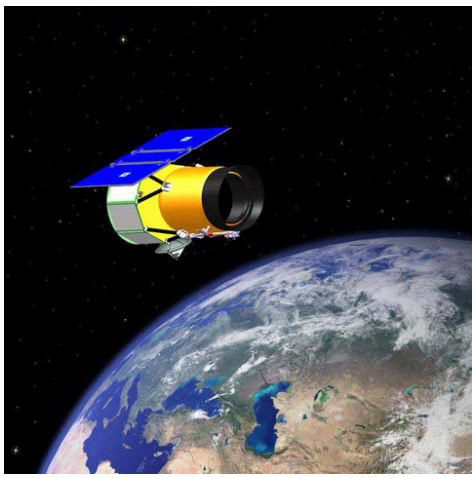
(Dollars in Millions)

Wide-field Infrared Survey Explorer (WISE)	FY2004	FY2005	FY2006
FY 2006 PRES BUD	11.4	55.0	71.9
Changes from FY 2005 Request	-19.3	-3.0	

Overview

Planned for launch in 2008, WISE will provide a storehouse of knowledge about the solar system, the Milky Way, and the Universe. During its six-month mission, WISE will map the sky in infrared light, searching for the nearest and coolest stars, the origins of stellar and planetary systems, and the most luminous galaxies in the universe. WISE's infrared survey will provide an essential catalog for the James Webb Space Telescope (JWST).

Solar panels will provide WISE with electricity as it orbits several hundred miles above the dividing line between night and day on Earth, looking out at right angles to the Sun and always pointing away from the planet. As the telescope orbits from the North Pole to the equator to the South Pole and then back up to the North Pole, it will sweep out a circle in the sky. As the Earth moves around the Sun, this circle will shift, until WISE has observed the entire sky.



Artist's depiction of WISE satellite in orbit.

For more information, please visit:
http://wise.ssl.berkeley.edu/science.html

Changes From FY 2005

- N/A

Program Management

JPL is responsible for WISE project management. NASA and JPL Program Management Councils have program oversight responsibility.

Technical Description

WISE is a satellite with an infrared-sensitive telescope that will image the entire sky. Since objects near room temperature emit infrared radiation, the telescope and detectors are kept cold (below -430° F/15°K) by a cryostat -- like an ice chest filled with solid hydrogen.

As WISE sweeps the sky, a small mirror will scan in the opposite direction, capturing an image onto an infrared sensitive digital camera every 11 seconds. Each picture will cover an area of the sky 3 times larger than the Moon. After 6 months, WISE will have taken nearly 1,500,000 pictures covering the sky. Data will be downloaded by radio transmission 4 times per day to computers on the ground which will combine the images into an atlas covering the entire celestial sphere, and a list of all the detected objects

Theme:	The Universe
Program:	Explorer
Project In Formulation:	Wide-field Infrared Survey Explorer (WISE)

Schedule

Date	Key Milestones	Change From FY 2005
May 2005	Preliminary Design Review	N/A
June 2005	Confirmation Review	N/A
July 2005	Phase C/D Start	N/A
June 2008	Launch	N/A

Strategy For Major Planned Acquisitions

- The cryogenic instrument is being built by Space Dynamics Laboratory; Ball Aerospace and Technologies Corporation is building the spacecraft.

Key Participants

- UCLA is the lead Principal Investigator; the science team also includes members from Caltech, UC Berkeley, the University of Arizona, and the University of Virginia.

  Science operations and data processing will take place at the JPL/Caltech Infrared Processing and Analysis Center.

Theme:	The Universe
Program:	International Space Science Collaboration
Project In Development:	Herschel

President's FY 2006 Budget Request

(Dollars in Millions)

Herschel	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010
FY 2006 PRES BUD	18.3	5.3	6.9	12.6	28.0	27.4	25.9
Changes from FY 2005 Request	6.6	-0.8	0.4	6.5	28.0	27.4	

Overview

The Herschel Space Observatory will be the first example of a new generation of space telescopes. It will be the first space observatory covering the full far-infrared and sub-millimeter waveband, and its telescope will have the largest mirror ever deployed in space. It will be located 1.5 million kilometers away from Earth at the second Lagrange point of the Earth-Sun system. Herschel will permit high spatial and spectral resolution imaging in the 85-900 micron wavelength region. Superb sensitivity for both photometry and spectroscopy will result from Herschel's high throughput and low thermal background. Herschel's 3.5 meter mirror will collect the light from distant and poorly known objects, such as newborn galaxies thousands of millions of light-years away, and will focus it onto three instruments with detectors kept at temperatures close to absolute zero.

Artist's impression of Herschel observatory.

Herschel will be an infrared telescope used to study: galaxy formation and evolution in the early universe; the nature of active galaxy power sources; star forming regions; and interstellar medium physics in the Milky Way and other galaxies. Herschel will be a multipurpose observatory serving the entire astronomical community. Herschel is led by the European Space Agency (ESA) with NASA providing U.S. participation on two instruments. Project is in development, therefore has baselined a life cycle cost commitment.

For more information, please see: http://sci.esa.int/science-e/www/area/index.cfm?fareaid=16

Changes From FY 2005

- In 2004, ESA announced a six-month launch delay which is reflected in the outyear budget.
- Technical difficulties in the development of flight hardware for Herschel resulted in cost increases.

Program Management

JPL - Herschel project management, including mission and science operations.
NASA and JPL Program Management Councils - program responsibility.

Theme:	The Universe
Program:	International Space Science Collaboration
Project In Development:	Herschel

Technical Description

Herschel will be the first observatory to cover the full far-infrared and sub-millimeter waveband and its telescope will have the largest mirror ever deployed in space. It will be 1.5 million kilometers away from Earth, and a 3.5 meter mirror will collect light from distant and poorly known objects millions of light years away and focus it onto three instruments with detectors kept at temperatures close to absolute zero.

Schedule

Date	Key Milestones	Change From FY 2005
August 2007	Launch	

Strategy For Major Planned Acquisitions

- Herschel is an ESA mission.
  NASA is providing critical components and technologies.

Key Participants

- Herschel is an ESA mission.
  NASA is providing critical components and technologies to this mission.

Risk Management

- RISK: It is possible that flight hardware will be damaged during integration and testing prior to launch. MITIGATION: NASA is building spare components for the critical pieces of the flight hardware.
- RISK: Potential launch delay due to ESA spacecraft and instrument schedule issue. MITIGATION: NASA will deliver U.S.-developed hardware (instrument components) as soon as flight units have been built and tested.

Budget Detail/Life Cycle Cost (Dollars in Millions)

Budget Authority	Prior	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010	BTC	Total	Comments
FY 2006 PRES BUD	71.4	18.3	5.3	6.9	12.6	28.0	27.4	25.9	120.1	315.9	
Changes		6.6	-0.8	0.4	6.5	28.0	27.4		120.1	214.1	
FY2005 President's Budget	71.4	11.7	6.1	6.5	6.1					101.8	

Theme:	The Universe
Program:	International Space Science Collaboration
Project In Development:	Planck

President's FY 2006 Budget Request

(Dollars in Millions)

Planck	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010
FY 2006 PRES BUD	13.5	7.1	5.3	8.3	9.6	8.9	6.4
Changes from FY 2005 Request	1.1	-0.6	-0.8	3.3	9.6	8.9	

Overview

Planck will help provide answers to one of the most important sets of questions asked in modern science: how did the universe begin, how did it evolve to the state we observe today, and how will it continue to evolve in the future? Planck's objective is to analyze, with the highest accuracy ever achieved, the remnants of the radiation that filled the universe immediately after the Big Bang, which researchers observe today as the cosmic microwave background (CMB). Planck will study the global characteristics of the universe (age, composition, topology, etc.) by its precision all-sky measurement of the CMB. Planck is designed to image minor variations in CMB radiation over the whole sky, with unprecedented sensitivity and angular resolution. Planck is led by ESA. NASA participates on the two project instruments.

For more information, please see: http://sci.esa.int/science-e/www/area/index.cfm?fareaid=17.

Artist's impression of Planck observatory.

Changes From FY 2005

- In 2004, ESA announced a six-month launch delay which is reflected in the Planck outyear budget.

Program Management

JPL - Planck project management, including mission and science operations.
NASA and JPL Program Management Councils - program responsibility.

Technical Description

Planck will collect and characterize radiation from the CMB using sensitive radio receivers operating at extremely low temperatures. The receivers will determine the black body equivalent temperature of the background radiation and be capable of distinguishing temperature variations of about one microkelvin. The measurements will produce the best ever maps of aniosotopies in CMB radiation field.

Schedule

Date	Key Milestones	Change From FY 2005
October 2007	Launch.	

Theme:	The Universe
Program:	International Space Science Collaboration
Project In Development:	Planck

Strategy For Major Planned Acquisitions

- Planck is an ESA mission.
  NASA is providing critical components and technologies to this mission.

Key Participants

- Planck is an ESA mission.
  NASA is providing critical components and technologies to this mission.

Risk Management

- RISK: Potential launch delay due to ESA spacecraft and instrument schedule issue.
  MITIGATION: NASA will deliver U.S. developed hardware (instrument components) as soon as flight units have been built and tested.
- RISK: It is possible that flight hardware will be damaged during integration and testing prior to launch. MITIGATION: NASA is building spare components for the critical pieces of the flight hardware.

Budget Detail/Life Cycle Cost (Dollars in Millions)

Budget Authority	Prior	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010	BTC	Total	Comments
FY 2006 PRES BUD	37.7	13.5	7.1	5.3	8.3	9.6	8.9	6.4	12.2	109.0	
Changes		1.1	-0.6	-0.8	3.3	9.6	8.9		12.2	40.1	
FY2005 President's Budget	37.7	12.4	7.7	6.1	5.0					68.9	

Theme:	Earth-Sun System
Program:	Earth Systematic Missions
Project In Development:	Ocean Surface Topography Mission

President's FY 2006 Budget Request

(Dollars in Millions)

Ocean Surface Topography Mission	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010
FY 2006 PRES BUD	28.9	30.5	26.3	18.8	13.4	7.5	6.7
Changes from FY 2005 Request	28.9	30.5	26.3	18.8	13.4	7.5	

Overview

The Ocean Surface Topography Mission (OSTM) is a cooperative effort between NASA, the National Oceanic and Atmospheric Administration (NOAA), the European Organization for the Exploitation of Meteorological Satellites (EUMETSAT), and the Centre National d'Etudes Spatiales (CNES), the space agency of France. OSTM is a follow-on to Jason and will provide continuity of ocean topography measurements beyond Jason and TOPEX/Poseidon. Launch is targeted for FY 2008. OSTM will measure sea surface height to an accuracy of < 4 centimeters every ten days. Sea surface topography, as measured by satellite altimeters, has numerous applications important to global environmental monitoring, including predicting hurricane intensification, improving tide models, mapping deep ocean bathymetry, monitoring, and forecasting El Niño Southern Oscillation, measuring the rate of global sea level rise, and charting surface currents. OSTM supports Objective 14 and APG 6ESS25. Applications of OSTM data will include coastal zone and disaster management.

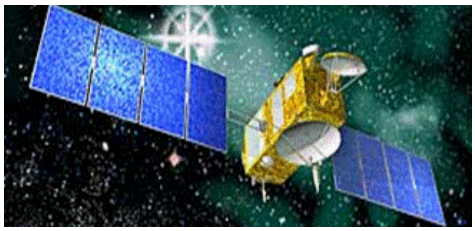


Image of the Ocean Surface Topography Mission (OSTM) spacecraft.

Changes From FY 2005

- Replan of Mission Confirmation Review by 8 months to April 2005 and launch to April 2008.

Program Management

JPL has project management responsibility. The NASA and JPL Program Management Councils have program oversight responsibility.

Technical Description

OSTM will have a three year operational life with a five year goal. It will carry 6 scientific instruments. NASA will provide the Advanced Microwave Radiometer (AMR), the Global Positioning System Payload (GPSP), the Laser Retroreflector Array (LRA), and potentially the optional experimental Wide Swath Ocean Altimeter (WSOA). CNES will provide the Nadir Altimeter and the Doppler Orbitography and Radiopositioning Integrated by Satellite (DORIS) instruments. The Nadir Altimeter will provide vertical measurements of sea surface height; the AMR will provide atmospheric correction for the Nadir Altimeter; the GPS Payload, LRA, and the DORIS will provide precision orbit determination; and the WSOA will demonstrate new high resolution measurement of ocean surface topography

Theme:	Earth-Sun System
Program:	Earth Systematic Missions
Project In Development:	Ocean Surface Topography Mission

Schedule

Date	Key Milestones	Change From FY 2005
Apr 05	Missin Confirmation Review	+8 months
Apr 08	Launch	+8 months

Strategy For Major Planned Acquisitions

- The AMR and WSOA (if option selected) to be built in-house by JPL and GPSP, LRA to be selected by full and open competition.
- The Nadir Altimeter, DORIS and spacecraft to be provided by foreign partner (CNES).
- The launch vehicle to be provided through full and open competition.

Key Participants

- CNES: Areas of cooperation include spacecraft, instruments, and mission operations.
- EUMETSAT: Areas of cooperation include Earth terminal, data processing, and archiving.
- NOAA: Areas of cooperation include mission operations, data processing, and archiving.

Budget Detail/Life Cycle Cost (Dollars in Millions)

Budget Authority	Prior	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010	BTC	Total	Comments
FY 2006 PRES BUD	54.6	28.9	30.5	26.3	18.8	13.4	7.5	6.7	2.7	189.4	
Changes	54.6	28.9	30.5	26.3	18.8	13.4	7.5		2.7	189.4	
FY2005 President's Budget											

Theme:	Earth-Sun System
Program:	Earth Systematic Missions
Project In Development:	NPOESS Preparatory Project (NPP)

President's FY 2006 Budget Request

(Dollars in Millions)

NPOESS Preparatory Project (NPP)	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010
FY 2006 PRES BUD	102.6	135.2	62.5	12.2	6.0	6.2	6.2
Changes from FY 2005 Request	-0.9	-5.9	0.9	5.3	6.0	6.2	

Overview

The NPOESS Preparatory Project (NPP) is a joint mission with NOAA and the U.S. Air Force (USAF) to extend key environmental measurements in support of long-term monitoring of climate trends and global biological productivity. The mission of NPP is two-fold: First, NPP will provide NASA with the continuation of global change observations following the Earth Observing System (EOS) missions Terra and Aqua, specifically, atmospheric and sea surface temperatures, humidity sounding, land and ocean biological productivity, and cloud and aerosol properties. Secondly, NPP will provide the National Polar-orbiting Operational Environmental Satellite System (NPOESS) with risk reduction demonstration and validation for the critical NPOESS sensors, algorithms, and processing. The NPP launch is planned for October 2006 with an operational life of 5 years. NPP supports Objective 14 and AGP 6ESS23.

For more information see http://science.hq.nasa.gov/missions/satellite_58.htm.

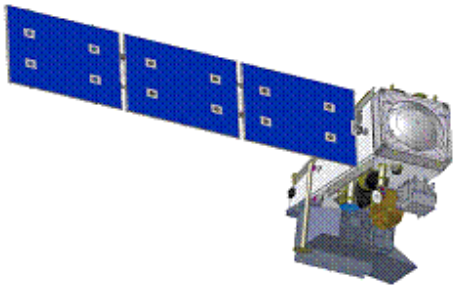


Image of the NPP spacecraft.

Changes From FY 2005

- Assumes no changes.

Program Management

GSFC is responsible for NPP project management. The NASA and GSFC Program Management Councils have program oversight responsibility.

Technical Description

The NPP spacecraft will carry four instruments that will provide continuity of imagery, sounding, and ozone mapping and profiling observations for NASA. The satellite will provide regional and global meteorological data as well as oceanographic, environmental and climactic information. The Advanced Technology Microwave Sounder (ATMS) and the Cross-track Infrared Sounder (CrIS) will provide improved measurements of temperature and moisture profiles in the atmosphere. The Visible Infrared Imaging Radiometer Suite (VIIRS) will provide global imagery in a number of visible and infrared frequency bands. The Ozone Mapping and Profiler Suite (OMPS) will collect ozone data in support of the U.S. treaty obligation to monitor the ozone depletion for the Montreal Protocol.

Theme:	Earth-Sun System
Program:	Earth Systematic Missions
Project In Development:	NPOESS Preparatory Project (NPP)

Schedule

Date	Key Milestones	Change From FY 2005
Oct 04	Spacecraft Integration Complete	
Apr 05	ATMS Flight Model Delivery	
Sep 05	OMPS Flight Model Delivery	
Oct 05	CrIS Flight Model Delivery	
Nov 05	VIIRS Flight Model Delivery	
Jun 06	Operational Readiness Review	
Oct 06	Launch	

Strategy For Major Planned Acquisitions

- Not applicable. All procurements for NPP are completed.

Key Participants

- NPOESS Integrated Program Office (a joint program office inclusive of NASA, NOAA, and USAF): responsible for procuring CrIS, OMPS, VIIRS, ground system, and data processing system.
- NOAA is responsible for providing long-term data archive and storage.

Risk Management

- RISK: If instruments are not delivered in accordance with agreed upon dates, then serious observatory integration and test delays may be realized. There is a very high likelihood that this risk will cause major cost increases and a schedule impact of at least 6 months.
  MITIGATION: NASA and NOAA/IPO team working together to identify further work-arounds to minimize cost and schedule impacts.

Budget Detail/Life Cycle Cost (Dollars in Millions)

Budget Authority	Prior	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010	BTC	Total	Comments
FY 2006 PRES BUD	256.1	102.6	135.2	62.5	12.2	6.0	6.2	6.2		587.1	
Changes	0.0	-0.9	-5.9	0.9	5.3	6.0	6.2			17.9	
FY2005 President's Budget	256.1	103.5	141.1	61.6	6.9					569.2	

Theme:	Earth-Sun System
Program:	Earth Systematic Missions
Project In Formulation:	Global Precipitation Mission

President's FY 2006 Budget Request

(Dollars in Millions)

Global Precipitation Mission	FY2004	FY2005	FY2006
FY 2006 PRES BUD	29.2	26.3	24.0
Changes from FY 2005 Request	1.2	-3.1	

Overview

The Global Precipitation Mission (GPM) is a joint mission with the Japan Aerospace Exploration Agency (JAXA) and other international partners. Building upon the success of the Tropical Rainfall Measuring Mission (TRMM), it will initiate the measurement of global precipitation, a key climate factor. Its science objectives are to: improve climate prediction by providing near-global measurement of precipitation, its distribution, and physical processes; improve the accuracy of weather and precipitation forecasts through more accurate measurement of rain rates and latent heating; and provide more frequent and complete sampling of Earth's precipitation. GPM will consist of a core spacecraft to measure precipitation structure and to provide a calibration standard for the constellation spacecraft; an international constellation of NASA and contributed spacecraft to provide frequent precipitation measurements on a global basis; calibration/validation sites distributed globally with a broad array of precipitation-measuring instrumentation, and a global precipitation data system to produce and distribute global rain maps and climate research products. Launches are targeted for FY 2011 and FY 2012. GPM supports Objective 14 and AGP 6ESS22.

Global Precipitation Mission (GPM) constellation.

For more information see
http://science.hq.nasa.gov/missions/earth-sun.html

Changes From FY 2005

- Assumes NASA purchasing spacecraft from industry through the Rapid Spacecraft Development Office.

Program Management

GSFC has project management responsibility. The NASA and GSFC Program Management Councils have program oversight responsibility.

Technical Description

The core and constellation spacecraft have a three-year operational life with a five year goal. Other U.S. (POES and NPOESS) and international satellites part of the GPM constellation have similar lifetimes. The core and constellation spacecraft carry three scientific instruments. The Dual-frequency Precipitation Radar (DPR) supplied by JAXA and the GPM Microwave Imagers (GMI) supplied by NASA will fly on the core spacecraft. A GMI will also fly on the NASA constellation spacecraft. The DPR measures the horizontal and vertical structure of rainfall and its microphysics. The GMIs provide additional sampling to improve global rainfall accumulations and extend scientific and societal applications through "calibration" of the other constellation satellites' microwave radiometers.

Theme:	Earth-Sun System
Program:	Earth Systematic Missions
Project In Formulation:	Global Precipitation Mission

Schedule

Date	Key Milestones	Change From FY 2005
Jan 06	Mission Confirmation Review	
Jun 10	Launch	

Strategy For Major Planned Acquisitions

- DPR to be provided by foreign partner (JAXA) and GMI to be selected by full and open competition.
- Core spacecraft to be selected by full and open competition. Constellation spacecraft to be selected by full and open competition.
- Launch vehicle to be provided by foreign partner (JAXA).

Key Participants

- JAXA - Areas of cooperation include DPR, core spacecraft launch, and ground validation.
- European Space Agency/Canadian Space Agency - Areas of cooperation include constellation satellite, instruments, launch, and ground validation.
- CNES - Areas of cooperation include constellation satellite, instruments, launch, and ground validation.

Theme:	Earth-Sun System
Program:	Earth Systematic Missions
Project In Formulation:	Glory

President's FY 2006 Budget Request

(Dollars in Millions)

Glory	FY2004	FY2005	FY2006
FY 2006 PRES BUD	12.3	54.2	5.1
Changes from FY 2005 Request	0.2	0.2	

Overview

The Glory mission improves upon NASA's research of forcings that influence climate change in the atmosphere. The scientific knowledge such global satellite observations will provide is essential to predicting climate change and to making sound, scientific based economic and policy decisions related to environmental change. The Glory Aerosol Polarimetry Sensor (APS) is an advanced polarimeter to increase our understanding of black carbon soot and other aerosols as causes of climate change. The APS will provide unprecedented determination of the global distribution of natural and human-made aerosols and clouds with accuracy and coverage sufficient for a reliable quantification of the aerosol direct and indirect effects on climate. The solar Total Irradiance Monitor (TIM), a second Glory instrument, provides measurements to maintain an uninterrupted total solar irradiance data record by bridging the gap between NASA's Solar Radiation and Climate Experiment (SORCE) and the National Polar Orbiting Operational Environmental Satellite System (NPOESS) missions. Solar radiation is the dominant, direct energy input into the terrestrial ecosystem, affecting all physical, chemical, and biological processes. These measurements are critical in studies to understand the Sun, its direct and indirect affect on the Earth system, and its influence on humankind. Glory supports Objective 14 and AGP 6ESS25.

Glory Logo

For more on the scientific questions addressed by Glory, visit www.climatescience.gov.

Changes From FY 2005

- Assumes continued build of the APS and TIM instruments; needs flight opportunity

Program Management

GSFC has project management responsibility. The NASA and GSFC Program Management Councils have program oversight responsibility.

Technical Description

The Glory mission will consist of a two-instrument development effort, the APS and TIM. Flight opportunities for the instruments are under review but are not identified at this time. APS represents the next generation of spaceborne measurement capability by simultaneously providing multispectral and multi-polarization data, as well as along-track multi-angle scanning ability. The Glory APS provides some risk mitigation for the operational instrument planned to fly on the NPOESS mission. The solar TIM is a state-of-the-art radiometer based upon heritage from the successful SORCE instrument.

Theme:	Earth-Sun System
Program:	Earth Systematic Missions
Project In Formulation:	Glory

Schedule

Date	Key Milestones	Change From FY 2005
May 05	Mission Confirmation Review	
Jan 08	Instrument Delivery	

Strategy For Major Planned Acquisitions

- Not applicable. All procurements for Glory are complete.

Key Participants

- Columbia University collaborates with the Goddard Institute of Space Studies on APS science requirements, algorithms, and instrument operations, with participation by NOAA/IPO scientists to maximize value to NPOESS.
- University of Colorado provides TIM science and instrument operations expertise.

Theme:	Earth-Sun System
Program:	Earth Systematic Missions
Project In Formulation:	Landsat Data Continuity Mission (LDCM)

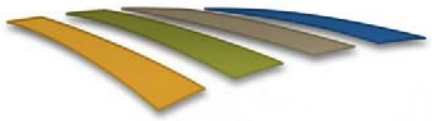
President's FY 2006 Budget Request

(Dollars in Millions)

Landsat Data Continuity Mission (LDCM)	FY2004	FY2005	FY2006
FY 2006 PRES BUD	35.2	38.4	54.3
Changes from FY 2005 Request	-24.4	-3.5	

Overview

The Landsat Data Continuity Mission (LDCM) is a joint NASA-United States Geological Survey (USGS) mission to extend the Landsat record of multispectral, 30-meter resolution, seasonal, global coverage of the Earth's land surface beyond the Landsat-7 lifetime. LDCM will continue the global land cover data set with provision of synoptic, repetitive multispectral, high-resolution, digital imagery of Earth's land surfaces, and will improve assessment of rates of land-cover changes. NASA and the USGS are working together to ensure the continuity of Landsat data through development of the LDCM system with the assessment of various system development and management options for a satellite system to succeed Landsat 7. Although many options are viable, the partners are focusing on a solution that will satisfy the goals set forth in the Land Remote Sensing Policy Act of 1992 of maintaining "data continuity with the Landsat system," to serve "the civilian, national security, commercial, and foreign policy interests of the United States," and to "incorporate system enhancements... which may potentially yield a system that is less expensive to build and operate and more responsive to users." One of the key objectives of LDCM is to make all Landsat equivalent data collected available at affordable cost. This will enable the many different sectors of the population - farmers, school children, business leaders, scientists, state and federal governments, and many others to continue to utilize this data for high quality research and applications. This program supports Objective 14 and APG 6ESS25.



Landsat Data Continuity Mission (LDCM) logo.

For more information on LDCM, go to:
http://science.hq.nasa.gov/missions/satellite_56.htm

Changes From FY 2005

- Rephasing delivery of the second Operational Land Imager (OLI) Instrument; delivered 2 years after the first OLI delivery to NPOESS.

Program Management

GSFC is responsible for LDCM project management. The NASA and GSFC Program Management Councils have program oversight responsibility.

Theme:	Earth-Sun System
Program:	Earth Systematic Missions
Project In Formulation:	Landsat Data Continuity Mission (LDCM)

Technical Description

LDCM will procure two instruments each with a mission lifetime of 5 years to provide continuity to the Landsat 7 dataset. The LDCM instrument, the OLI will have heritage emphasis on the visible and near-infrared ranges with approximately 9 bands at 30-meter resolution and will enable cross-sensor comparison of any data from within the Landsat series. LDCM will most likely be flown in a sun-synchronous, near-polar orbit, with a mid-morning equatorial crossing time. LDCM data will ensure a minimum of once yearly full global coverage the Earth's complete land mass, coastal boundaries, and coral reefs as well as high-interest shorter repeat cycle phenomenological studies.

Schedule

Date	Key Milestones	Change From FY 2005
Jul 06	Mission Confirmation Review	New Milestone
Dec 08	Instrument Delivery	New Milestone

Strategy For Major Planned Acquisitions

- OLI: To be selected by full and open competition.

Key Participants

- USGS: areas of cooperation include data management, data distribution, on-orbit calibration and validation, and on-orbit payload operations.
- NOAA: provides spacecraft and instrument integration.

Theme:	Earth-Sun System
Program:	Living with a Star
Project In Development:	Solar Dynamics Observatory

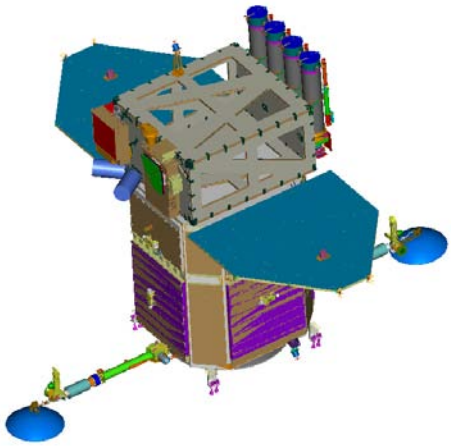
President's FY 2006 Budget Request

(Dollars in Millions)

Solar Dynamics Observatory	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010
FY 2006 PRES BUD	88.1	148.4	159.2	154.1	55.0	18.6	16.1
Changes from FY 2005 Request	22.3	-10.0	30.3	41.4	14.1	-0.5	

Overview

The Solar Dynamics Observatory (SDO) is the Living With a Star (LWS) program's first mission. It will investigate how the Sun's magnetic field is structured and how its energy is converted and released into the heliosphere in the forms of solar wind, energetic particles, and variations in solar irradiance. Scientists will analyze data from three instruments, the Helioseismic and Magnetic Imager (HMI), the Extreme Ultraviolet Variability Experiment (EVE), and the Atmospheric Imaging Assembly (AIA), to improve the science needed to enable space weather predictions. The project includes funding for the spacecraft, launch vehicle, data analysis (6 years), project operations (5 years), education, and outreach.



SDO Spacecraft

SDO will explain where and how the Sun's changing magnetic field is generated throughout the solar system. SDO's data set will also become the primary source for U.S. operational space weather activities.

For more information, please see: http://sdo.gsfc.nasa.gov/

Changes From FY 2005

- Critical Design Review was delayed 2 months due to technical issues; no change to follow-on milestones.

Program Management

GSFC is responsible for mission management, design, integration, testing and operation.

Technical Description

SDO will be in geosynchronous orbit. It will take data (~130 Mbps), down-link it to a ground station in White Sands, NM, and then forward it to the investigators without processing.

Schedule

Date	Key Milestones	Change From FY 2005
June 2004	Mission Confirmation Review	Delayed two months
Apr 2005	Critical Design Review	Delayed two months
Jan 2006	Complete Spacecraft Structure	
Feb 2007	Instrument Delivered to Spacecraft	
Apr 2008	Launch	

Theme:	Earth-Sun System
Program:	Living with a Star
Project In Development:	Solar Dynamics Observatory

Strategy For Major Planned Acquisitions

- HMI instrument purchased through Stanford University via Announcement of Opportunity competitive selection.
- EVE instrument purchased through the University of Colorado.
- AIA instrument purchased through Lockheed Martin via sole source justification (replaced SHARPP instrument with Naval Research Laboratory).

Key Participants

- Lockheed Martin Missiles and Space Advanced Technology Center providing AIA instrument.
- Stanford University providing the HMI instrument.
- LASP at University of Colorado providing the EVE instrument.

Risk Management

- RISK: Late addition of a secondary payload could invalidate analyses and test results and cause interface design rework and rebuild. MITIGATION: The SDO program may identify secondary payload/launch vehicle schedule and technical requirements and provide them to KSC.
- RISK: Problems with the Field Programmable Gate Array (FPGA) may be uncovered after Engineering Test Unit (ETU) build is complete. MITIGATION: The SDO program may work with FPGA applications experts to use best information and recommendations for FPGA use.
- RISK: The imposition of more stringent security requirements late in the development cycle could cause redesign and rework. MITIGATION: The SDO program may allocate resources to thoroughly understand impacts from proposed new security requirements.
- RISK: There may be increased procurement costs due to reductions in the spacecraft market. MITIGATION: The SDO program may work with industry to understand cost and competition drivers and modify requirements, where appropriate.

Budget Detail/Life Cycle Cost (Dollars in Millions)

Budget Authority	Prior	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010	BTC	Total	Comments
FY 2006 PRES BUD	67.7	88.1	148.4	159.2	154.1	55.0	18.6	16.1		707.3	
Changes	0.0	22.3	-10.0	30.3	41.4	14.1	-0.5		-52.6	61.3	
FY2005 President's Budget	67.7	65.8	158.4	128.9	112.7	40.9	19.1		52.6	646.1	

The FY 06 increase for SDO reflects the baseline budget requirements. Funding was transferred from within the LWS program to support this increase.

Theme:	Earth-Sun System
Program:	Solar Terrestrial Probes
Project In Development:	Solar Terrestrial Relations Observatory (STEREO)

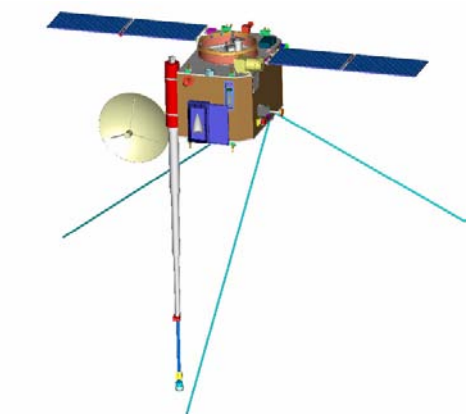
President's FY 2006 Budget Request

(Dollars in Millions)

Solar Terrestrial Relations Observatory (STEREO)	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010
FY 2006 PRES BUD	123.2	69.0	47.7	19.2	14.3	9.9	10.0
Changes from FY 2005 Request	24.5	-4.8	15.1	-0.1	2.0	7.0	

Overview

The STEREO project will lead to an understanding of the cause and consequences of coronal mass ejections (CME) by: tracing the flow of CMEs from the Sun to Earth; discovering the mechanisms and sites of energetic particle acceleration in the Sun's corona and the interplanetary medium; and developing a three-dimensional time-dependent model of the ambient solar wind. STEREO will also continuously transmit data that will be used to predict space weather. STEREO will use two identically equipped spacecraft in heliocentric orbits, with one leading Earth and the other lagging Earth. Investigations for STEREO will include: Sun Earth Connection Coronal and Heliospheric Investigation (SECCHI), a remote sensing package which will study the three-dimensional evolution of CMEs from the Sun's surface to their eventual impact at Earth; STEREO/WAVES (SWAVES), an interplanetary radio burst tracker that will trace traveling radio disturbances from the Sun to Earth; In situ Measurements of Particles and CME Transients (IMPACT) investigation, which will sample the three-dimensional distribution of solar wind plasma, characteristics of solar energetic particles, and the local vector magnetic field; and the PLAsma and SupraThermal Ion and Composition (PLASTIC) experiment, which will study coronal-solar wind and solar-wind heliospheric processes. Project supports annual performance goals 6ESS8 and 6ESS16.



STEREO Spacecraft

For more information, please see
http://stp.gsfc.nasa.gov/missions/stereo/stereo.htm

Changes From FY 2005

- Increase in spacecraft and instrument costs due to technical and associated schedule issues. Rephase expendable launch vehicle payment.

Program Management

STEREO is the third mission within the STP program, with program and project responsibility delegated to Goddard Space Flight Center.

Technical Description

The mission design life shall be at least two years for each spacecraft. Assuming a CME rate consistent with minimum of solar magnetic activity cycle, STEREO will observe at least 60 CMEs with remote sensing instruments and at least 24 interplanetary events in situ. STEREO will have two major science instrument suites and two science instruments. The Applied Physics Laboratory will provide mission operations.

Theme:	Earth-Sun System
Program:	Solar Terrestrial Probes
Project In Development:	Solar Terrestrial Relations Observatory (STEREO)

Schedule

Date	Key Milestones	Change From FY 2005
May 2001	Start of Formulation	
Mar 2002	Start of Implementation	
Feb 2003	Mission Critical Design Review	
Sept 2004	Complete Spacecraft integration & testing (I & T)	Technical issues delayed 4 months
June 2005	Complete Observatory Spacecraft I & T	Technical issues delayed 5 months
Nov 2005	Launch	Technical issues delayed 3 months

Strategy For Major Planned Acquisitions

- Major acquisitions complete.

Key Participants

- APL will provide the spacecraft, observatory integration, testing and mission operations.
- NRL will provide the SECCHI remote sensing instrument suites.
- The United Kingdom will provide two Heliospheric Imager instruments.

Risk Management

- RISK: It is highly likely that there will be degradation of observatory mass margin.
  MITIGATION: The program will perform a series of instrument and spacecraft mass estimate scrubs to verify confidence in remaining estimate margins, and will lighten remaining spacecraft subsystem hardware if possible. The program will consider adjusting the launch window and/or mission design to exercise mass saving options, as required.
- RISK: The IMPACT Solar Energic Particles Development schedule may erode due to technical problems.
  MITIGATION: The program will prioritize schedule for the mechanical development, and will provide additional questions and answers, engineering and management support to the IMPACT team.

Budget Detail/Life Cycle Cost (Dollars in Millions)

Budget Authority	Prior	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010	BTC	Total	Comments
FY 2006 PRES BUD	164.9	123.2	69.0	47.7	19.2	14.3	9.9	10.0		458.1	
Changes	0.0	24.5	-4.8	15.1	-0.1	2.0	7.0			53.7	
FY2005 President's Budget	164.9	98.7	73.8	32.6	19.3	12.3	2.9			404.5	

STEREO cost increase reflects schedule slip of launch date by three months, instruments increases due to technical problems with the instruments and schedule delay with spacecraft provider. The increase was accommodated within the Solar Terrestrial Program.

Theme:	Earth-Sun System
Program:	Solar Terrestrial Probes
Project In Development:	Solar-B

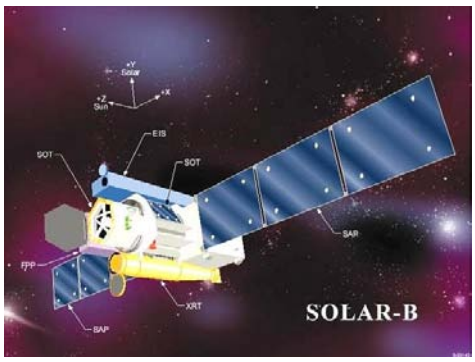
President's FY 2006 Budget Request

(Dollars in Millions)

Solar-B	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010
FY 2006 PRES BUD	16.8	11.4	14.3	14.7	12.5	12.5	10.1
Changes from FY 2005 Request	4.4	-0.8	3.0	14.7	12.5	12.5	

Overview

The Solar-B mission is the second mission in the STP program. Solar-B is an international collaboration building on the highly successful Japan/U.S./UK Yohkoh (Solar-A) project. Solar-B is expected to launch in September 2006 into a sun-synchronous low Earth orbit. It will measure the Sun's magnetic field and ultraviolet/X-ray radiation and use the data to increase the understanding of the sources of solar variability. Solar-B will specifically study the interaction between the Sun's magnetic field and its high-temperature, ionized atmosphere. The result will be an improved understanding of the mechanisms that give rise to solar magnetic variability and how this variability modulates the total solar output and creates the driving force behind space weather. The U.S. responsibility is to manage development of three science instrument components: the Focal Plane Package (FPP), the X-Ray Telescope (XRT), and the Extreme Ultraviolet (EUV) Imaging Spectrometer (EIS).



Solar-B Spacecraft

For more information, please see:
http://stp.gsfc.nasa.gov/missions/solar-b/solar-b.htm

Changes From FY 2005

- No changes.

Program Management

The Solar-B project is within the STP program, with program management responsibility delegated to GSFC. Solar-B project management is at MSFC.

Technical Description

The FPP will be designed to operate in conjunction with the JAXA-provided 0.5 meter solar optical telescope; the XRT will accommodate the JAXA-provided camera and the EIS elements will be designed and constructed to be integral to the United Kingdom-provided EIS instrument. Mission design life is three years.

Schedule

Date	Key Milestones	Change From FY 2005
Sept 2006	Solar-B Launch	None

Strategy For Major Planned Acquisitions

- None

Theme:	Earth-Sun System
Program:	Solar Terrestrial Probes
Project In Development:	Solar-B

Key Participants

- Lockheed Martin Missiles and Space will provide the focal plane package.
- The Smithsonian Astrophysical Observatory will provide x-ray telescope.
- The Naval Research Laboratory will provide the EUV Imaging Spectrograph.
- JAXA will provide spacecraft, launch vehicle, major elements of each scientific instrument, observatory integration and testing, and mission operations.

Risk Management

- RISK: Delays in partner testing and/or launch schedule would impact overall project schedule and cost. MITIGATION: The program will continue to negotiate schedules with Japan and will prioritize future budgets to determine any necessary reductions in project support to accommodate possible cost increases.

Budget Detail/Life Cycle Cost (Dollars in Millions)

Budget Authority	Prior	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010	BTC	Total	Comments
FY 2006 PRES BUD	82.1	16.8	11.4	14.3	14.7	12.5	12.5	10.1		174.3	
Changes		4.4	-0.8	3.0	14.7	12.5	12.5			56.3	
FY2005 President's Budget	82.1	12.4	12.2	11.3						118.0	

Theme:	Earth-Sun System
Program:	Explorer Program
Project In Development:	Aeronomy of Ice in the Mesosphere (AIM)

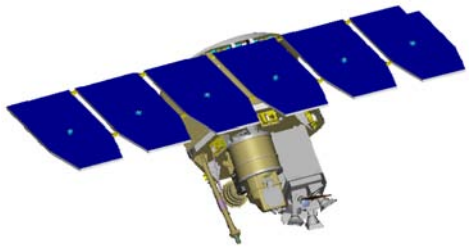
President's FY 2006 Budget Request

(Dollars in Millions)

Aeronomy of Ice in the Mesosphere (AIM)	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010
FY 2006 PRES BUD	21.9	30.1	27.3	6.0	3.9	3.0	3.0
Changes from FY 2005 Request	-17.9	-2.1	15.0	5.3	3.9	3.0	

Overview

AIM will determine the causes of Earth's highest-altitude clouds, which form in the coldest part of the atmosphere about 50 miles above the polar regions every summer. Recorded sightings of these "night-shining," or noctilucent clouds, began in the late 1800s and have increased in frequency. The clouds have also extended to lower latitudes over the past four decades. Scientists have hypothesized that these changes may be related to changes in atmospheric trace gas concentrations and the temperatures they produce. Similar thin high altitude clouds have been observed on Mars. The information AIM provides about Earth's noctilucent clouds should help scientists understand the similarities and differences between the atmospheres of Mars and Earth.



AIM Spacecraft

AIM's three instruments, the Cloud Imaging and Particle Size (CIPS), Solar Occultation for Ice Experiment (SOFIE), and the Cosmic Dust Experiment (CDE), will measure all of the parameters important to understanding noctilucent cloud formation, which will help scientists determine the connection between the clouds and their environment and will serve as a baseline for the study of long-term changes in the upper atmosphere. Project supports annual performance goals 6ESS13.

For more information, please see:
http://aim.hamptonu.edu/

Changes From FY 2005

- Confirmed to proceed into development in April 2004.

Program Management

AIM is a NASA Small Explorer (SMEX) spacecraft with management responsibility delegated to Goddard Space Flight Center.

Technical Description

AIM is a SMEX-class mission that will be launched from Vandenberg Air Force Base on a Pegasus XL launch vehicle on September 2006. The spacecraft, developed by Orbital, will be launched into a sun-synchronous orbit of 600 kilometers. Three instruments, CIPS, SOFIE and CDE, will each perform unique stand-alone measurements. The baseline mission duration is 24 months.

Theme:	Earth-Sun System
Program:	Explorer Program
Project In Development:	Aeronomy of Ice in the Mesosphere (AIM)

Schedule

Date	Key Milestones	Change From FY 2005
Apr 2004	AIM Confirmation Review	delayed one month
Mar 2005	Spacecraft I&T Begins	
Oct 2005	Observatory I&T Begins	
Sep 2006	Launch	

Strategy For Major Planned Acquisitions

- AIM is a principal investigator (PI)-led mission. The PI, at Hampton University's Center for Astropheric Science, leads the science, instrument, and spacecraft teams.

Key Participants

- Hampton University - Principal Investigator
- Laboratory for Atmospheric and Space Physics (LASP)at the University of Colorado provides project management, instruments (CIPS, CDE and SOFIE), and mission operations (subcontacted to Hampton University).
- Orbital Science Corp (a subcontractor to LASP) provides the spacecraft bus and will provide observatory integration and testing.

Risk Management

- RISK: The replacement of Actel field programmable gate arrays may impact schedule. MITIGATION: If necessary the project will "borrow" sufficient parts from another project to permit instrument replacement to proceed without schedule impact to fabrication.

Budget Detail/Life Cycle Cost (Dollars in Millions)

Budget Authority	Prior	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010	BTC	Total	Comments
FY 2006 PRES BUD	21.1	21.9	30.1	27.3	6.0	3.9	3.0	3.0		116.3	
Changes	0.0	-17.9	-2.1	15.0	5.3	3.9	3.0			10.2	
FY2005 President's Budget	21.1	39.8	32.2	12.3	0.7					106.1	

Theme:	Earth-Sun System
Program:	Explorer Program
Project In Development:	Thermal Emission Imaging System (THEMIS)

President's FY 2006 Budget Request

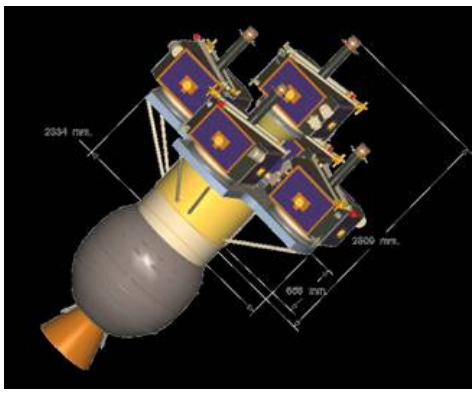
(Dollars in Millions)

Thermal Emission Imaging System (THEMIS)	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010
FY 2006 PRES BUD	68.8	51.6	38.8	11.8	6.3	4.0	4.0
Changes from FY 2005 Request	68.8	51.6	38.8	11.8	6.3	4.0	

Overview

The THEMIS project will lead to the understanding of the onset and evolution of magnetospheric substorms. NASA's THEMIS mission will use five identical microspacecraft (probes) to answer fundamental outstanding questions regarding magnetospheric substorm instability, a dominant mechanism of transport and explosive release of solar wind energy within Geospace. THEMIS will also employ a dense network of ground observatories to time well known plasma particles and fields signatures in Earth's magnetotail, relative to substorm onset. In addition to addressing its primary objective, THEMIS answers critical questions in radiation belt physics and solar wind-magnetosphere energy coupling.

For more information, please see:
http://sprg.ssl.berkeley.edu/themis/Flash/THEMIS_flash.htm



THEMIS Spacecraft

Changes From FY 2005

- THEMIS was confirmed to proceed into development in April 2004.

Program Management

THEMIS is a NASA Medium-clss Explorer (MIDEX) mission, with project responsibility delegated to the Goddard Space Flight Center.

Technical Description

THEMIS is Medium-Class Explorer (MIDEX) mission that will be launched from Cape Canaveral, Florida, on a Delta II in October 2006. THEMIS consists of 5 identical probes. There are five instruments on each probe: fluxgate magnetometer (FGM), search coil magnetometer (SCM), electric field instrument (EFI), electrostatic analyzer (ESA) and solid state telescope (SST).

Theme:	Earth-Sun System
Program:	Explorer Program
Project In Development:	Thermal Emission Imaging System (THEMIS)

Schedule

Date	Key Milestones	Change From FY 2005
Apr 2004	THEMIS Confirmed	Baseline Schedule
Mar 2005	Instrument I&T Begins	
July 2005	Spacecraft Integration and Testing Begins	
Mar 2006	Observatory Integration and Testing Begins	
Oct 2006	Launch	

Strategy For Major Planned Acquisitions

- UCB will provide the 3 instruments and the mission and science operations.
- Swales Aerospace will provide the spacecraft, integration and test, spacecraft carrier, launch vehicle integration, and launch support to UCB.

Key Participants

- Univerity of California at Berkeley - Prinicpal Investigator.
- Swales Aerospace Corporation is providing the spacecraft bus.
- International Instruments: France - SCM; Germany - FGM.

Risk Management

- RISK: The baseline design for probe release mechanism fails to meet mission requirements, necsssitating a redesign. This activity may impact schedule reserves. MITIGATION: The project will develop an engineering test unit to support early tesing.
- RISK: Orbital debris analysis (ODA) of the launch vehicle (Delta II second and third stages) indicateds non-compliance with orbital debris guideline. Subsequent changes in the orbital design may impact science.
  MITIGATION: the project will meet with NASA Headquarters' Science Mission Directorate and Safety Office to discuss ODA non-compliance.

Budget Detail/Life Cycle Cost (Dollars in Millions)

Budget Authority	Prior	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010	BTC	Total	Comments
FY 2006 PRES BUD	12.1	68.8	51.6	38.8	11.8	6.3	4.0	4.0		197.4	
Changes	12.1	68.8	51.6	38.8	11.8	6.3	4.0			197.4	
FY2005 President's Budget											

Theme:	Earth-Sun System
Program:	Earth System Science Pathfinder
Project In Development:	Cloudsat

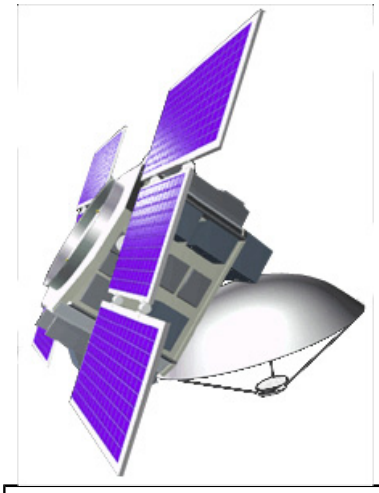
President's FY 2006 Budget Request

(Dollars in Millions)

Cloudsat	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010
FY 2006 PRES BUD	29.2	8.0	4.8	1.3			
Changes from FY 2005 Request	12.8	4.9	3.4	1.3			

Overview

CloudSat observations will improve cloud modeling, contributing to better predictions of cloud formation and distribution and to a better understanding of the role of clouds in Earth's climate system. Clouds are the key component of Earth's hydrological cycle, and they dominate the planet's solar and thermal radiation budgets. Even small changes in their abundance or distribution could significantly alter the climate. These considerations lead scientists to believe that the main uncertainties in climate model simulations are due to the difficulties in adequately representing clouds and their radiative properties. CloudSat will fly a millimeter-wave (94 GHz) radar that is capable of seeing a large fraction of clouds and precipitation, from very-thin cirrus clouds to thunderstorms producing heavy precipitation. CloudSat will furnish data needed to evaluate and improve the way clouds are represented in global models, thereby contributing to better predictions of clouds and a more complete knowledge of their role in climate change. CloudSat, a collaboration among NASA, the Canadian Space Agency (CSA), and the U.S. Air Force (USAF), is co-manifested with CALIPSO for launch aboard a Boeing Delta II rocket. The mission will fly in formation with CALIPSO and as part of a larger constellation with Aura and Aqua and the French satellite, Parasol. This project supports Objective 14 and Agency Performance Goal 6ESS25.



CloudSat has a nadir pointing radar optimized to penetrate clouds and reveal their interior water and aerosol content.

For more information see http://CloudSat.atmos.colostate.edu/

Changes From FY 2005

- Mission requirements replanned. Launch delay of 2 months to May 2005.

Program Management

JPL is responsible for project management. The NASA, GSFC, and JPL Program Management Councils have program oversight responsibility.

Theme:	Earth-Sun System
Program:	Earth System Science Pathfinder
Project In Development:	Cloudsat

Technical Description

The single CloudSat instrument is the Cloud Profiling Radar (CPR). The CPR is a 94-GHz nadir-looking radar that measures the power backscattered by clouds as a function of distance from the radar. CloudSat will be co-manifested with CALIPSO on a Delta II launch vehicle. CloudSat will fly in formation with CALIPSO as part of the "A-Train" constellation. The CloudSat CPR provides calibrated, range-resolved radar reflectivity measurements. The USAF will provide ground operations and manage communications to the satellite. The data will be routed through the Air Force facility at Kirtland Air Force Base to the Colorado State University Cooperative Institute for Research in the Atmosphere (CIRA). CIRA will be responsible for processing, archiving and distributing the mission science data.

Schedule

Date	Key Milestones	Change From FY 2005
Jul 04	Instrument delivery to S/C to start satellite AIT	
Jan 05	Satellite environmental tests complete	
Mar 05	Delivery to Launch Site	
May 05	Launch	+2 months
May 06	First data products delivered	+2 months
Mar 07	End of primary mission	+2 months

Strategy For Major Planned Acquisitions

- None remaining.

Key Participants

- Colorado State University: provides Principal Investigator and data processing
- JPL: provides instrument development, integration, and test
- CSA: provides CPR key element; USAF: provides ground stations for mission operations
- DoE: provides early mission calibration and validation phase expertise

Risk Management

- RISK: If formation flying with CALIPSO and the insertion into the A-Train cannot be achieved, then optimum science results will not be achieved. There is a moderate likelihood that formation flying and insertion into the A-Train will not be achieved to make optimum use of the instrument synergy of the different A-Train satellites. MITIGATION: NASA established the A-Train constellation working group, made up of representatives from all satellite organizations, and led by the GSFC Earth Science Mission operations office, to identify and resolve formation flying and A-Train insertion issues.

Budget Detail/Life Cycle Cost (Dollars in Millions)

Budget Authority	Prior	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010	BTC	Total	Comments
FY 2006 PRES BUD	119.3	29.2	8.0	4.8	1.3					162.6	
Changes	0.0	12.8	4.9	3.4	1.3					22.5	
FY2005 President's Budget	119.3	16.4	3.1	1.4						140.2	

Theme:	Earth-Sun System
Program:	Earth System Science Pathfinder
Project In Development:	Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO)

President's FY 2006 Budget Request

(Dollars in Millions)

Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO)	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010
FY 2006 PRES BUD	40.8	14.5	3.5	4.7	2.8		
Changes from FY 2005 Request	12.6	4.4	-0.2	2.1	2.7	-0.1	

Overview

CALIPSO mission will address the role of clouds and aerosols in Earth's atmosphere, providing key measurements to improve knowledge of their three, dimensional distribution, radiative properties, and effect on Earth's climate. The mission will fly a 3-channel lidar (a laser) in formation with CloudSat and in a constellation with Aura and Aqua to obtain coincident observations of radiative fluxes and the atmosphere. This set of measurements is essential for quantification of global aerosol and cloud radiative effects. CALIPSO consists of a partnership between NASA and France's Centre Nationale D'Etudes Spatiale (CNES). CNES is providing a Proteus spacecraft, the imaging infrared radiometer (IIR), integrated observatory integration and test, and spacecraft mission operations. Together, CALIPSO and Aqua provide: (1) a global measurement suite from which the first observationally based estimates of aerosol direct radiative forcing of climate can be made; (2) a dramatically improved empirical basis for assessing aerosol indirect radiative forcing of climate; (3) a factor of 2 improvement in the accuracy of satellite estimates of long-wave radiative fluxes at Earth's surface and in the atmosphere; and (4) a new ability to assess cloud-radiation feedback in the climate system. CALIPSO is co-manifested with CloudSat and scheduled to launch no earlier than May 2005. This project supports Objective 14 and Agency Performance Goal 6ESS25.

The CALIPSO satellite will provide data key to understanding the role of clouds and aerosols in Earth's radiation budget, providing key measurements to improve climate predictions.

For more information see http://www-calipso.larc.nasa.go

Changes From FY 2005

- Mission requirements replanned. Launch delay of 2 months to May 2005.

Program Management

GSFC has project management responsibility. The NASA and joint LaRC/GSFC Program Management Councils have program oversight responsibility.

Theme:	Earth-Sun System
Program:	Earth System Science Pathfinder
Project In Development:	Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO)

Technical Description

CALIPSO carries three science instruments: a three-channel LIDAR, and IIR, and a wide field camera (WFC). The LIDAR and WFC are provided by NASA and the IIR by CNES. CALIPSO will launch with CloudSat on a Delta II launch vehicle into 705 kilometer altitude, 98.08' inclined orbit, and will fly in formation with CloudSat and in a larger constellation with Aura, Aqua, and Parasol. The science data sets produced by CALIPSO will include aerosol and cloud vertical distributions, aerosol extinction and optical depth, optical depth, emissivity, and effective particle size content of clouds and cloud surface atmospheric radiative fluxes. The Mission Operations Control Center will be at LaRC and the Satellite Operations Control Center at CNES facilities in Toulouse, France

Schedule

Date	Key Milestones	Change From FY 2005
Mar 04	Payload (all 3 instruments) delivery to spacecraft	
Apr 05	Satellite delivery to launch site	
May 05	Launch	+2 months
Nov 06	1st calibrated & validated data products delivered	+2 months
May 08	End of primary mission	+2 months

Strategy For Major Planned Acquisitions

- N/A, all procurements for CALIPSO are completed

Key Participants

- GSFC - Provides project and program management
- LaRC - Provides principle investigator and primary instrument (LIDAR)
- CNES - Provides spacecraft, system level integration and testing, and satellite ground station and mission control

Risk Management

- RISK: If formation flying with CloudSat and the insertion into the A-Train can not be achieved, then optimum science results will not be achieved. There is a moderate likelihood that formation flying and insertion into the A-Train will not be achieved to make optimum use of the instrument synergy of the different A-Train satellites. MITIGATION: NASA established the A-Train constellation working group, made up of representatives from all satellite organizations, and led by the GSFC Earth Science Mission operations office, to identify and resolve formation flying and A-Train insertion issues.

Budget Detail/Life Cycle Cost (Dollars in Millions)

Budget Authority	Prior	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010	BTC	Total	Comments
FY 2006 PRES BUD	118.5	40.8	14.5	3.5	4.7	2.8				184.7	
Changes	0.0	12.6	4.4	-0.2	2.1	2.7	-0.1			21.5	
FY2005 President's Budget	118.5	28.2	10.1	3.7	2.6	0.1	0.1			163.3	

Theme:	Earth-Sun System
Program:	Earth System Science Pathfinder
Project In Formulation:	Orbiting Carbon Observatory

President's FY 2006 Budget Request

(Dollars in Millions)

Orbiting Carbon Observatory	FY2004	FY2005	FY2006
FY 2006 PRES BUD	18.9	37.5	46.9
Changes from FY 2005 Request	1.3	-7.9	

Overview

The Orbiting Carbon Observatory (OCO) mission is part of ESSP in the NASA Science Mission Directorate. OCO was competitively selected from proposals submitted in response to ESSP Announcement of Opportunity 3. OCO will make the first space-based measurements of atmospheric carbon dioxide (CO2) with the precision, resolution, and coverage needed to characterize its sources and sinks on regional scales and quantify their variability over the seasonal cycle. The data received from OCO will provide an improved understanding of CO2 sinks, a critical element in making more reliable climate predictions. OCO will help address two important Earth science questions: 1) What human and natural processes are controlling atmospheric CO2; and 2) What are the relative roles of the oceans and land ecosystems in absorbing CO2? This project supports Objective 14 and APG 6ESS25.

For more information, please see http://sciencedev.hq.nasa.gov/missions/satellite_61.htm.

Image of the Orbiting Carbon Observatory (OCO) Spacecraft

Changes From FY 2005

- OCO schedule rephased.

Program Management

OCO is led by a PI from the JPL. Project management and the Program Management Council responsibility also reside at JPL.

Technical Description

During its two-year mission, OCO will fly in a Sun-synchronous polar orbit that provides near-global coverage of the sunlit portion of Earth, with a 16-day repeat cycle. The spacecraft is a high-heritage low earth orbit Star-2, provided by Orbital Sciences Corporation. Its single instrument incorporates three high-resolution grating spectrometers, designed to measure the near-infrared absorption by CO2 and molecular oxygen in reflected sunlight. The orbit's early afternoon equator crossing time maximizes the available signal and minimizes diurnal biases in CO2 measurements associated with photosynthesis.

Theme:	Earth-Sun System
Program:	Earth System Science Pathfinder
Project In Formulation:	Orbiting Carbon Observatory

Schedule

Date	Key Milestones	Change From FY 2005
Apr 05	Mission Confirmation Review	
Oct 07	Launch	

Strategy For Major Planned Acquisitions

- There are no planned major procurements, as all instrument and spacecraft contracts are in place.

Key Participants

- There are no development partners outside of NASA.
- New Zealand's National Institute of Water and Atmospheric Research, France's Laboratoire des Sciences du Climat et de l'Environnement, and Germany's University of Bremen are all members of the OCO Science Team.

Theme:	Earth-Sun System
Program:	Earth System Science Pathfinder
Project In Formulation:	Hydros

President's FY 2006 Budget Request

(Dollars in Millions)

Hydros	FY2004	FY2005	FY2006
FY 2006 PRES BUD			4.6
Changes from FY 2005 Request			

Overview

The Hydrosphere State (Hydros) mission is part of ESSP. Hydros was competitively selected from proposals submitted in response to ESSP Announcement of Opportunity 3. Hydros will provide global views of the terrestrial water cycle, soil moisture content and its freeze/thaw state. The science goals for Hydros are to: provide resolution of the terrestrial water budget mean state and variability, improve water supply forecasts for water management and agriculture, and enhance predictive skill (lead time and accuracy) for weather, climate, and carbon balance. The science of Hydros introduces improved capability to predict costly natural hazards, such as extreme weather, floods, and droughts. This Project supports Objective 14 and APG 6ESS25.

For more information, please see http://sciencedev.hq.nasa.gov/missions/satellite_62.htm.

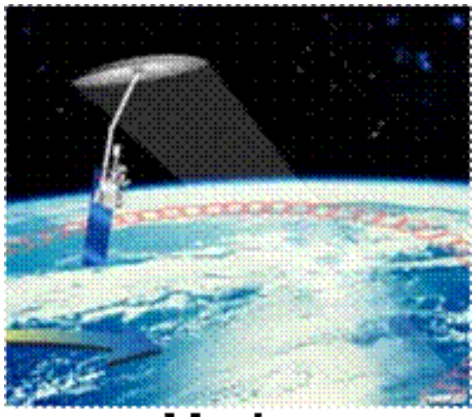


Image of the Hydros Spacecraft

Changes From FY 2005

- Hydros was competitively selected from proposals submitted in response to ESSP Announcement of Opportunity 3.

Program Management

Project management responsibility resides at JPL. The NASA and JPL Program Management Councils have program oversight responsibility.

Technical Description

Hydros will be launched into a polar, sun synchronous orbit that allows global measurements of Earth's changing soil moisture and land surface freeze/thaw conditions. The payload on Hydros will consist of an L-band radar and radiometer with a shared 6-meter rotating antenna. The Hydros satellite is planned to operate for two years. The combined readings from the radar and radiometer will provide data through most vegetation and will provide soil moisture measurements to a greater depth than any other space based system.

Theme:	Earth-Sun System
Program:	Earth System Science Pathfinder
Project In Formulation:	Hydros

Schedule

Date	Key Milestones	Change From FY 2005
Jul 07	Mission Confirmation Review	
Dec 10	Launch	

Strategy For Major Planned Acquisitions

- Project selection of the antenna vendor will be conducted in FY 2006 via full and open competition.

Key Participants

- MIT provides the PI and contributes to the science team and science operations.
- CSA provides the Antenna Feed Assembly and radar processing (Memorandum of Understanding not finalized).

Theme:	Earth-Sun System
Program:	Earth System Science Pathfinder
Project In Formulation:	Aquarius

President's FY 2006 Budget Request

(Dollars in Millions)

Aquarius	FY2004	FY2005	FY2006
FY 2006 PRES BUD	8.1	19.1	55.3
Changes from FY 2005 Request	-0.1	-1.4	

Overview

The Aquarius Mission is part of ESSP. Aquarius was competitively selected from proposals submitted in response to ESSP Announcement of Opportunity 3. Aquarius is an instrument on the Argentine Comisión Nacional de Actividades Espaciales (CONAE) spacecraft SAC-D. Aquarius will make space-based measurements of sea surface salinity (SSS), with high accuracy and resolution to investigate the links between the global water cycle, ocean circulation, and climate. The objective of Aquarius is to observe and model seasonal and year-to-year variations of SSS, and how these relate to changes in the water cycle and ocean circulation. This will yield an unprecedented view of the oceans' role in climate and weather. This project supports Objective 14 and APG 6ESS25.

For more information, please see http://sciencedev.hq.nasa.gov/missions/satellite_59.htm.

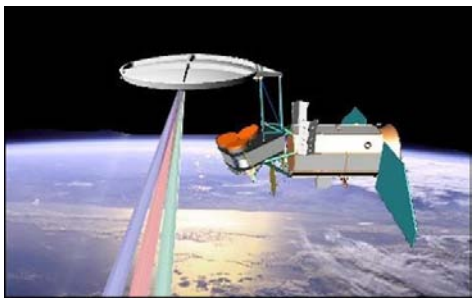


Image of the Aquarius Spacecraft

Changes From FY 2005

- Mission Confirmation Review rephased to occur June 2005.

Program Management

Aquarius is led by a PI from Earth and Space Research. Project management and Program Management Council responsibility reside at JPL.

Technical Description

This observatory will be launched into a polar, sun-synchronous orbit that allows global coverage of ice free ocean surfaces, consistent with SAC-D science observational targets. The Aquarius mission will provide for a 3-year data set. CONAE will conduct the operations. Aquarius will deploy an integrated passive/active L-band radiometer/scatterometer as the primary salinity-measuring payload. JPL will design and build the scatterometer which will utilize surface radar backscatter for mitigating salinity measurement errors due to surface roughness effects. GSFC will design and build the L-Band radiometer which will provide the primary sea surface brightness measurement used to derive SSS.

Theme:	Earth-Sun System
Program:	Earth System Science Pathfinder
Project In Formulation:	Aquarius

Schedule

Date	Key Milestones	Change From FY 2005
Jun 05	Mission Confirmation Review	-2 months (correction)
Sep 08	Launch	No change

Strategy For Major Planned Acquisitions

- There are no planned major procurements, as all instrument and spacecraft contracts are in place.

Key Participants

- CONAE will provide the spacecraft, ground systems, and operations.

Theme:	Constellation Systems
Program:	Earth Orbit Capability (Spiral 1)
Project In Formulation:	Crew Exploration Vehicle (Spiral 1)

President's FY 2006 Budget Request

(Dollars in Millions)

Crew Exploration Vehicle (Spiral 1)	FY2004	FY2005	FY2006
FY 2006 PRES BUD	75.0	140.1	752.9
Changes from FY 2005 Request	75.0	140.1	

Overview

The Crew Exploration Vehicle (CEV) will provide human transportation capability from the surface of the Earth to orbit by 2014. It will be designed from the outset as a key element of the Constellation System of Systems and will provide the capability for human transportation beyond Earth orbit by no later than 2020. The capabilities of the CEV will be extensible to future missions in a sustainable, affordable manner as new technology becomes available. The CEV will provide a flexible crew vehicle capable of supporting multiple exploration missions to orbital destinations such as the Moon, Mars and beyond.

The Crew Exploration Vehicle is the centerpiece of the Constellation System of Systems.

The CEV Project Office was established at NASA Headquarters within the Constellation Systems Theme in FY 2004. The CEV project has recruited a diverse team of experts from across the NASA Centers and brought them together at NASA Headquarters to develop a Request for Proposal for the CEV prime contractors. The CEV Request for Proposal will be released in March 2005 with a planned award in September 2005. NASA anticipates multiple awards that will continue up to Preliminary Design Review with a down-select following a flight test to demonstration risk reduction for the CEV in 2008.

The CEV project supports the Orbit Capability (Spiral 1) Program by providing the vehicle needed to demonstrate an Earth orbit capability, leading to a mission to the lunar surface.

For more information, please see http://exploration.nasa.gov/constellation/index.html.

Changes From FY 2005

- Since last year the program has established the CEV Project Office, developed a detailed acquisition strategy, and initiated formulation of the CEV prime contractor Request for Proposal.

Program Management

The CEV project is currently being managed from NASA Headquarters by ESMD, with future participation from the Space Operations Mission Directorate.

Theme:	Constellation Systems
Program:	Earth Orbit Capability (Spiral 1)
Project In Formulation:	Crew Exploration Vehicle (Spiral 1)

Technical Description

The CEV will be designed to: optimize crew safety while ensuring affordability and extensibility to future spirals; maximize the use of existing technology; maximize vehicle flexibility by employing an open systems architecture; and employ a simplified interface design with the crew launch vehicle. The CEV will be certified by testing to the maximum extent possible, and design of the CEV and its ground systems will be focused on achieving innovative and streamlined operations in order to reduce operational costs.

Schedule

Date	Key Milestones	Change From FY 2005
Mar 2005	Release Request for Proposal for CEV development	None
Sep 2005	Award contract for CEV (Spiral 1) development	None
2006	CEV System Readiness Review	None
2008	CEV Preliminary Design Review	None
2008	Risk Reduction Flight Demonstration	None

Strategy For Major Planned Acquisitions

- FY 2005 - Release and award multiple contracts for CEV phase 1 design and flight demonstration through Preliminary Design Review in 2008.

Key Participants

- Participants include eleven Concept Refinement and Exploration teams from industry and academia, and NASA insight through Integrated Product Teams.

Theme:	Constellation Systems
Program:	Earth Orbit Capability (Spiral 1)
Project In Formulation:	Crew Launch Vehicle (Spiral 1)

President's FY 2006 Budget Request

(Dollars in Millions)

Crew Launch Vehicle (Spiral 1)	FY2004	FY2005	FY2006
FY 2006 PRES BUD		11.1	14.3
Changes from FY 2005 Request		11.1	

Overview

The Crew Launch Vehicle (CLV) supports the Vision for Space Exploration by providing routine, safe, affordable, and reliable transportation of humans to low Earth orbit. The CLV will be evolvable in a sustainable and affordable manner to support future requirements. A key element of the Constellation System of Systems, the CLV will safely provide the necessary propulsive power to accelerate the CEV to low Earth orbit. Systems that comprise the CLV include the airframe structure and mechanisms (e.g. core stage, strap-on boosters, and upper stage), propulsion system (propellant distribution and engines), thermal management system, avionics (guidance, navigation and control), payload fairing, and system health management. The CLV also includes the launch vehicle element unique ground launch systems embedded in the ground infrastructure. The CLV will be integrated with ground support systems and the CEV for pre-launch preparations and airborne support (tracking, telemetry, range, recovery, etc.) during flight. The launch system architecture selected will meet the human-rating requirements, but may also have the capability to evolve to later cargo carrying requirements of future spirals. For more information, please see http://exploration.nasa.gov/constellation/index.html.

The Crew Launch Vehicle will provide a launch capability to enable humans to begin
their exploration journey.

Changes From FY 2005

- Formulation of the CLV acquisition strategy is being developed based on the lunar architecture analysis of alternatives to be completed in FY 2005.

Program Management

The CLV project is currently managed out of Headquarters by ESMD, with coordination and participation from the Space Operations Mission Directorate.

Technical Description

The CLV will meet key parameters such as: design for crew safety while ensuring a reasonable, feasible architecture (e.g. engine out capability, abort capability, etc.); mass-to-orbit, design reliability, minimal infrastructure requirements and standard payload interfaces; optimal functional allocations between the launch system and all other system interfaces; minimal and simple interfaces between the launch system and the CEV for optimum integration; minimal and simple interfaces between the launch system and the ground support system to allow for responsive and safe operations; and execution of a risk mitigation ground and flight test program to verify human-rating certification of the system.

Theme:	Constellation Systems
Program:	Earth Orbit Capability (Spiral 1)
Project In Formulation:	Crew Launch Vehicle (Spiral 1)

Schedule

Date	Key Milestones	Change From FY 2005
2006	Release Request for Proposal for CLV development	None
2007	Award contract for CLV development	None

Strategy For Major Planned Acquisitions

- FY 2006 - Release Request for Proposals for 2014 crew launch capability
- FY 2007 - Award contract for the CLV

Key Participants

- NASA is still developing its strategy for providing a crew launch capability. The BAA and RFP processes are part of the way NASA will dialogue with the broad external community to ensure that this capability is acquired in the most effective and efficient way possible for NASA and the Nation.
- Key participants are the Exploration Systems Mission Directorate, the Space Operations Mission Directorate, NASA Centers participation through Integrated Product Teams, and the launch vehicle industry.

Theme:	International Space Station
Program:	International Space Station Program
Project In Development:	Core Development

President's FY 2006 Budget Request

(Dollars in Millions)

Core Development	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010
FY 2006 PRES BUD	83.9	96.2	74.3	63.4	50.8	23.8	19.7
Changes from FY 2005 Request	-17.4	26.8	8.8	7.6	28.4	8.1	

Overview

Space Station elements are provided by U.S. and international partners Russia, Europe, Japan, and Canada. The U.S. elements include nodes, laboratory module, airlock, truss segments, photovoltaic arrays, three pressurized mating adapters, unpressurized logistics carriers, and a cupola. Various systems have been developed by the U.S., including thermal control, life support, navigation, command and data handling, power systems, and internal audio/video. Other U.S. elements being provided through bilateral agreements include the pressurized logistics modules provided by the Italian Space Agency, Node 2 provided by ESA, and the centrifuge accommodation module (CAM)/centrifuge provided by the Japanese. During FY 2005, it is expected the Space Shuttle will return to flight and the assembly of the ISS will resume in FY 2006. In the meantime, the ISS will continue on-orbit research operations with two crew and with resupply and crew rotation provided by Russian Progress and Soyuz vehicles.

ISS EVA operation.

Changes From FY 2005

- Shuttle Return to Flight in FY 2005
- NASA is examining configurations for the Space Station that meet the needs of both the space exploration vision and our international partners using as few Shuttle flights as possible.
- Columbia and Full Cost Impacts have significantly reduced program reserves.

Program Management

JSC is responsible for management of ISS core development. The NASA and JSC management Councils have program oversight responsibility.

Technical Description

The primary objective of the ISS is to support scientific research and other activities requiring the unique attributes of humans in space. In concert with the new exploration vision, NASA will refocus U.S. Space Station research on activities, such as the development of countermeasures against space radiation and the long-term effects of reduced gravity, that prepare human explorers to travel beyond low Earth orbit.

Theme:	International Space Station
Program:	International Space Station Program
Project In Development:	Core Development

Schedule

Date	Key Milestones	Change From FY 2005
December 2005	Flight 12A - P3/P4 Truss	Dates are subject to change
February 2006	Flight 12A.1 - P5 Truss	Dates are subject to change
April 2006	Flight 12A/1 - S3/S4 Truss	Dates are subject to change
June 2006	Flight 13A.1 - S5 Truss	Dates are subject to change
September 2006	Flight 15A - S6 Truss	Dates are subject to change
December 2006	Flight 10A - Node 2	Dates are subject to change

Strategy For Major Planned Acquisitions

- None

Key Participants

- International Partners; There are a total of 16 participating nations working on the ISS. Russia, ESA, Japan, Canada, and Italy are providing elements for the international Space Station
- Boeing; Prime contractor for International Space Station Development and Sustaining Engineering.
- Russia; in addition to ISS elements and crew members, Soyuz and Progress have provided critical crew rotation and resupply during the Shuttle hiatus.

Budget Detail/Life Cycle Cost (Dollars in Millions)

Budget Authority	Prior	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010	BTC	Total	Comments
FY 2006 PRES BUD	12,515.4	83.9	96.2	74.3	63.4	50.8	23.8	19.7		12,927.4	
Changes	0.0	-17.4	26.8	8.8	7.6	28.4	8.1			82.0	
FY2005 President's Budget	12,515.4	101.3	69.4	65.5	55.8	22.4	15.7			12,845.5	

Theme:	International Space Station
Program:	International Space Station Program
Project In Development:	Environmental Control and Life Support System (ECLSS)

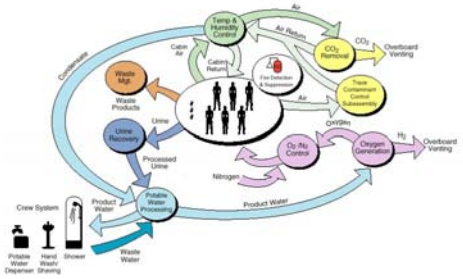
President's FY 2006 Budget Request

(Dollars in Millions)

Environmental Control and Life Support System (ECLSS)	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010
FY 2006 PRES BUD	25.7	10.4	18.1	8.1	4.0	3.4	2.5
Changes from FY 2005 Request	6.4	-0.8	8.8	4.4	4.0	3.4	

Overview

ISS Capability Upgrades enable potential enhancements to support research required by the National Vision for Space Exploration. NASA and the International Partners hope to increase the permanent crew of the ISS to greater than three. The additional crew is vital to full utilization of ISS capabilities for U.S. Exploration and International Partner goals. Development funding for the expansion of crew size above the U.S. Core baseline is included in the FY 2006 Capability Upgrades budget. Operations and sustaining will be included in the ISS operations budget. Regenerative environmental control and life support system (ECLSS), Node 3, and habitability modifications were funded from reserves in FY 2005, and the final design will be based on the ISS final configuration that emerges from the current reassessment.



Regenerative ECLSS.

Changes From FY 2005

- ECLSS, Node 3 and Habitability are included in the ISS program baseline
- ECLSS to be installed in the lab to provide early O2 generation capability.

Program Management

JSC has overall program management responsibility with MSFC providing the management of ECLSS development.

Technical Description

ECLSS, Node 3 and Habitability upgrades will provide the ability to sustain a crew size above three during continuous ISS operations. ECLSS provides a critical test bed for exploration and will provide redundancy from the Russian Electron for Oxygen generation up to 7,500 pounds. In addition the ECLSS will be able to recycle up to 41K of water. The habitability upgrades will provide crew accommodations and the Node 3 and additional 3470 cubic feet of volume.

Theme:	International Space Station
Program:	International Space Station Program
Project In Development:	Environmental Control and Life Support System (ECLSS)

Schedule

Date	Key Milestones	Change From FY 2005
March 2005	Oxygen Generator Assembly On Dock at MSFC	New Milestone
May 2005	Urine Processor Assembly bench test complete	Delayed four months
December 2005	Oxygen Generation System delivery to KSC	New Milestone
March 2006	Water Recovery System delivery to KSC	New Milestone
January 2008	Node 3 delivery to KSC	None

Strategy For Major Planned Acquisitions

- None

Key Participants

- Hamilton Sundstrand; performing major ECLSS orbital replacement unit development and rack level integration for two of three racks.
- Boeing; providing critical software and hardware for Node 3 and ECLSS integration to ISS
- Alenia; building Node 3 under contract with ESA.

Risk Management

- RISK: The Advanced ECLSS is a vital new technology. Development has seen technical challenges associated with delivery of key system components. These challenges are impacting program schedule. Delivery of the ECLSS could be impacted which would delay back up O2 regeneration capability or greater than three crew capability. MITIGATION: The program provides weekly status on all ECLSS technical issues with available schedule slack. Technical work arounds are currently in place with some contingency remaining.

Budget Detail/Life Cycle Cost (Dollars in Millions)

Budget Authority	Prior	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010	BTC	Total	Comments
FY 2006 PRES BUD	206.0	25.7	10.4	18.1	8.1	4.0	3.4	2.5		278.2	
Changes		6.4	-0.8	8.8	4.4	4.0	3.4			28.7	
FY2005 President's Budget	206.0	19.3	11.2	9.3	3.7					249.5	

Theme:	International Space Station
Program:	International Space Station Program
Project In Development:	ISS Cargo and Crew Services

President's FY 2006 Budget Request (Dollars in Millions)

ISS Cargo and Crew Services	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010
FY 2006 PRES BUD		98.0	160.0	160.0	160.0	500.0	720.0
Changes from FY 2005 Request		-42.0	0.0	0.0	0.0	0.0	

Overview

A key element in the future of the ISS program is the purchase of alternate cargo and crew transportation services to supplement the Shuttle when it is in service, and to replace it when it retires. The Space Shuttle has been the primary U.S. transportation vehicle for assembly and operation of the Space station since 1998 when STS-88 delivered and mated the Unity node to the Russian Control module, Zarya. NASA plans to continue use of the Space Shuttle as the workhorse vehicle for transporting large cargo to complete the assembly of the space station by the end of this decade. In 2010, the Space Shuttle - after nearly 30 years of duty - will be retired from service. Other U.S. systems to deliver crew and cargo to the ISS do not currently exist. It is necessary for NASA to establish a transportation capability for crew and cargo for the space station program both during ISS assembly and after the Shuttle is retired. NASA intends to meet this need through the purchase of services for cargo and crew transport using existing and emerging capabilities, both domestic and foreign. The purchase of these services is necessary to enable new ISS science capabilities, deliver and retrieve cargo, and provide human-rated crew transport for enterprise crew rotation when the Shuttle and partner-provided transportation is insufficient to meet space station requirements.

Changes From FY 2005

- A Cargo/Crew Services Aquisition Strategy has been developed

Program Management

ISS Program Office will manage program requirements and the Launch Services Program will manage the acquisition.

Technical Description

NASA intends to solicit a Request for Proposal (RFP) for commercial cargo transportation services to the ISS NLT June/July 2005 with an award expected by December 2005. The initial commercial cargo transportation system operational capability is expected NLT 2009.

Theme:	International Space Station
Program:	International Space Station Program
Project In Development:	ISS Cargo and Crew Services

Schedule

Date	Key Milestones	Change From FY 2005
March 2005	Draft RFP release	New Milestone
June 2005	Final RFP release	New Milestone
December 2005	Contract Awards	New Milestone

Strategy For Major Planned Acquisitions

- ISS Cargo Acquisition: To be selected by full and open competition.

Budget Detail/Life Cycle Cost (Dollars in Millions)

Budget Authority	Prior	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010	BTC	Total	Comments
FY 2006 PRES BUD			98.0	160.0	160.0	160.0	500.0	720.0		1,798.0	
Changes			-42.0							678.0	
FY2005 President's Budget			140.0	160.0	160.0	160.0	500.0			1,120.0	

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