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Statement of
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before the

Committee on Science and Technology
U.S. House of Representatives

Mr. Chairman and Members of the Committee, thank you for the opportunity to appear today to discuss the President's FY 2010 budget request for NASA. The President's FY 2010 budget request for NASA is $18.686 billion. The FY 2010 request represents an increase of $903.6 million above the amount provided for NASA in the FY 2009 Omnibus Appropriations Act (P.L. 110-8). The FY 2010 budget does a number of things: it supports the Administration's commitment to deploy a global climate change research and monitoring system; it funds a strong program of space exploration involving humans and robots with the goal of returning Americans to the moon and exploring other destinations; and it supports the safe flight of the Space Shuttle to complete assembly of the International Space Station by the Space Shuttle's planned retirement.

Highlights of the FY 2010 Budget Overview

With the FY 2010 budget request, NASA advances global climate change research and monitoring. The NASA investment in Earth science research satellites, airborne sensors, computer models and analysis has revolutionized scientific knowledge and predictions of climate change and its effects. Using the National Research Council's recommended priorities for space-based Earth science research as its guide, NASA will develop new space-based research sensors in support of the Administration's goal to deploy a global climate research and monitoring system. NASA will work to deploy these new sensors expeditiously while coordinating with other Federal agencies to ensure continuity of measurements that have long-term research and applications benefits.

The FY 2010 NASA request funds a robust program of space exploration involving humans and robots. NASA's astronauts and robotic spacecraft have been exploring our solar system and the universe for more than 50 years. The Agency will create a new chapter of this legacy as it works to return Americans to the Moon by 2020. NASA also will send a broad suite of robotic missions to destinations throughout the solar system and develop a bold new set of astronomical observatories to probe the mysteries of the universe, increasing investment in research, data analysis, and technology development in support of these goals.

With the FY 2010 request, NASA will complete the International Space Station (ISS) and advance the development of new space transportation systems and the unique scientific research that can be conducted onboard the ISS. The FY 2010 budget request funds for the safe flight of the Space Shuttle to complete the ISS, incorporates an additional flight to deliver the Alpha Magnetic Spectrometer (AMS) to the ISS,

and then retires the Shuttle. NASA is committed to completing these nine remaining scheduled Shuttle flights, including the current mission underway to service the Hubble Space Telescope, which we believe can be accomplished by the end of 2010. Funds freed from the Shuttle's retirement will enable the Agency to support development of systems to deliver people and cargo to the ISS and the Moon and explore other destinations. As part of this effort, NASA will stimulate private-sector development and demonstration of vehicles that may support the Agency's human crew and cargo requirements for ISS. In addition, the Agency will continue to utilize the ISS, the permanently crewed facility orbiting Earth that enables the Agency to develop, test, and validate critical space exploration technologies and processes, and to conduct microgravity research. NASA also will continue to coordinate with international partners to make this platform available for other government entities, commercial industry, and academic institutions to conduct research.

At the request of the Director of the Office of Science and Technology Policy, NASA is initiating an independent review of planned U.S. human space flight activities, with the goal of ensuring that the Nation is on a vigorous and sustainable path to achieving its boldest aspirations in space. This review will be conducted by a blue-ribbon panel of outside experts chaired by Norman R. Augustine. The panel will present its results in time to support an Administration decision on the way forward by August 2009. This Review of U.S. Human Space Flight Plans will examine ongoing and planned NASA human space flight development activities, as well as potential alternatives, and present options for advancing a safe, innovative, affordable, and sustainable human space flight program in the years following completion of the current Space Shuttle manifest and retirement. The independent review panel will seek input from Congress, the White House, the public, industry, and international partners. In addition, the review will examine the appropriate amount of R&D and complementary robotic activities needed to make human space flight activities most productive and affordable over the long term, as well as appropriate opportunities for international collaboration. It will also evaluate what capabilities would be enabled by each of the potential architectures considered. And it will evaluate options for extending International Space Station operations beyond 2016. We will keep the Congress informed, as appropriate, with the progress of the review.

It is important to note that the President has submitted a FY 2010 budget request for NASA Exploration Systems of $3.963 billion, an increase of $457.6 million above the FY 2009 Omnibus Appropriations level. During the review, the NASA workforce will continue to focus on the safe flight and operation of the Space Shuttle and ISS, and continue to work on all current exploration projects, including Ares I, Orion, and Commercial Crew and Cargo efforts.

The President's FY 2010 budget request includes $507 million for Aeronautics Research, renewing NASA's commitment to cutting-edge, fundamental research in traditional and emerging disciplines to help transform the Nation's air transportation system and to support future aircraft. NASA research will increase airspace capacity and mobility, enhance aviation safety, and improve aircraft performance while reducing noise, emissions, and fuel consumption. The Integrated Systems Research Program, a new program beginning in FY 2010, will conduct research at an integrated system-level on promising concepts and technologies and explore, assess, and demonstrate the benefits in a relevant environment.

Finally, consistent with Administration priorities, NASA is developing plans to stimulate innovation and increase investments in technologies for the future while ensuring that nearer-term Agency commitments are met.

NASA Initial FY 2009 Operating Plan and Recovery Act Funding

Before I highlight key accomplishments and plans for activities across the Agency, I would like to summarize NASA's initial FY 2009 Operating Plan, including Recovery Act funding, as recently submitted to the Committee. The initial FY 2009 Operating Plan is $18,784.4 million, or $1,170.2 million above the President's FY 2009 request, which reflects an increase of $168.2 million in the regular appropriation and $1,002.0 million in the Recovery Act. NASA is appreciative of the action by the Committees on Appropriations and Congress in providing regular appropriations for the Agency with full funding for Science, Aeronautics, Exploration, Space Shuttle, ISS, and Education. This total FY 2009 appropriations level, with minor adjustments within the total, will enable NASA to meet critical priorities, in accordance with the direction from the Congress and the President. NASA also appreciates the efforts by the Committees to include funding for NASA in the Recovery Act. This funding will help NASA achieve programmatic goals in Science, Exploration and Aeronautics, and repair damage done to the NASA Johnson Space Center during Hurricane Ike, and support national recovery goals.

NASA has allocated the $1,002.0 million in Recovery Act funds as follows:

- Science, $400.0M
  - Earth Science, $325.0M
  - Astrophysics, $75.0M
- Aeronautics, $150.0M
- Exploration, $400.0M
  - Constellation Systems, $250.0M
  - Commercial Crew & Cargo, $150.0M
- Cross Agency Support, $50.0M
- Inspector General, $2.0M

I would be happy to address the objectives to which NASA is applying the Recovery Act funds in detail.

Science

NASA's Science Mission Directorate continues to expand humanity's understanding of our Earth, our Sun, the solar system and the universe with 57 science missions in operation and 31 more in development. The Science budget funds these missions as well as the research of over 3,000 scientists and their students across the nation. The President's FY 2010 request for NASA includes $4,477.2 million for Science.

The Science budget request includes $1,405.0 million for **Earth Science** in FY 2010, and steadily increases Earth science funding in the outyears. NASA's 15 Earth Science missions in operation provide a large share of the global observations used for climate change research in the United States and elsewhere. This year, NASA's Earth Science satellites enabled research to understand how changes both in the tropics and in Arctic sea ice are changing ocean biology globally. NASA also recently conducted the first Ice Bridge aircraft campaign to demonstrate a new airborne laser capability to bridge the gap in time between ICESats 1 and 2. In FY 2010, NASA plans to launch the Glory mission to map atmospheric aerosols and continue the long record of solar influences on climate, and the Aquarius mission to provide the first global measurements of sea surface salinity. NASA will complete development of the NPOESS Preparatory Project and continue development of the Global Precipitation Mission and the Landsat Data Continuity Mission (LDCM). The request fully funds development of a Thermal Infra-red Sensor (TIRS) at a total cost of approximately $150-175 million. A decision whether to fly TIRS on LDCM or another spacecraft will be made this summer; meanwhile, funding for TIRS is carried within the LDCM budget. The launch vehicle failure of the Orbiting Carbon Observatory (OCO) was a significant loss to the climate science communities, and NASA is assessing options to recover from that loss; we will inform the

Congress of the results of these studies when they become available. NASA is continuing to work aggressively to implement the recommendations of the National Research Council Decadal Survey for Earth Science. The first two Decadal Survey missions, SMAP and ICESat-II, will continue formulation in FY2010, and the next two, DESDynI and CLARREO, will be accelerated and transition to formulation. NASA also expects to issue its first Venture-class Announcement of Opportunity later this year, implementing another important decadal survey recommendation.

The FY 2010 Science budget request includes $1,346.2 million for **Planetary Science**. NASA's Planetary Science missions continue to return images and data from the far reaches of the Solar System. This year, the Mars Phoenix Lander completed its mission, conducting the first chemical test providing evidence of water ice on another planet. MESSENGER returned stunning imagery of portions of the planet Mercury never before seen. The Cassini spacecraft continues to provide un-paralleled science of the Saturnian system; the spacecraft flew within 25km of Enceladus viewing the ejecting plumes and surface, and data from 19 fly-bys of Titan enabled creation of a radar map showing 3-D topography revealing 1,200-meter (4,000-foot) mountain tops, polar lakes, vast dunes, and thick flows from possible ice volcanoes. Development is continuing on the Juno mission to Jupiter for launch in 2011. NASA and ESA jointly announced they will work together on a Europa Jupiter System mission as the next outer planets flagship mission. The rovers Spirit and Opportunity continue to study the Martian surface and have exceeded their fifth year of successful operations. NASA is continuing development of the Mars Science Laboratory (MSL) for launch in 2011 and selected MAVEN, a Mars aeronomy mission, as the next Mars Scout mission for launch in 2013. NASA has integrated its lunar science research program with the Lunar Precursor Robotic Program into a single Lunar Quest Program under the Science Mission Directorate, which includes the LADEE mission, the U.S. nodes of the ILN, and a new virtual university research collaboration called the NASA Lunar Science Institute. The Moon Mineralogy Mapper (M3) was launched aboard Chandrayaan-1 and has begun making scientific observations of the Moon's composition. Development is continuing on the GRAIL mission to map the Moon's gravity field for launch in 2011. NASA has issued an Announcements of Opportunity for the next New Frontiers mission, and will do so for the next Discovery mission later this year.

The FY2010 Science budget request includes $1,120.9 million for **Astrophysics**. 2009 is the International Year of Astronomy, and NASA's Astrophysics program will deploy exciting new capabilities for studying the cosmic frontier. The Kepler mission, launched in March, is NASA's first mission dedicated to the search for Earth-like planets in our galaxy. ESA will launch the Herschel and Planck missions in April, carrying several NASA instruments, to study the far-infrared sky and the cosmic microwave background. The final Hubble Space Telescope serving mission aboard STS-125, currently in progress, is upgrading the observatory to its peak scientific performance. Late this calendar year, NASA plans to launch the Wide-field Infrared Survey Explorer (WISE) as part of its highly successful Explorer Program, following on the recent successes of the Fermi Gamma-ray Space Telescope (launched as GLAST in July 2008), which has provided the best-ever view of the gamma-ray sky revealing energetic sources in our solar system, our galaxy, and galaxies billions of light-years away. Development is continuing on the James Webb Space Telescope, which passed its Confirmation Review in 2008 and has an Agency commitment to launch in 2014. Development continues on the NuSTAR mission to study black holes for launch in 2011, along with a Soft X-ray Spectrometer to fly on Japan's Astro-H mission in 2013. Development continues on the airborne Stratospheric Observatory for Infrared Astronomy or SOFIA, which will conduct open door flight tests in 2009 and early science flights in 2010, with planned full operational capability in 2014. Conceptual design is continuing for ambitious future mission concepts to investigate the origins of planets, stars, and galaxies; to search for Earth-like planets around nearby stars; and to examine the nature of dark energy, dark matter, gravity waves, and black holes. These and other mission concepts are currently under consideration by the NRC's decadal survey for Astrophysics, or Astro2010, which will be completed during 2010, and will provide recommendations

to NASA on the science community's highest priority science questions and strategic missions for the next decade.

The FY2010 Science budget request includes $605.0 million for **Heliophysics**. The fleet of NASA Heliophysics missions strategically placed throughout the solar system is providing researchers the first ever solar system-wide view of solar influences on the Earth and other planets, and the dynamic structures of space itself. This virtual "Great Observatory" is in place and functioning for the next solar magnetic activity cycle, and has already detected the first signs of a new solar maximum anticipated for 2011-2012. Late this year or early next, the launch of Solar Dynamics Observatory will add to this fleet the capability to observe the solar atmosphere to a depth one-third of the Sun's radius to study the flow of plasmas that generate magnetic fields and the sudden changes that produce coronal mass ejections that we experience as space weather. Also this year, NASA plans to select two Small Explorer (SMEX) missions in response to an Announcement of Opportunity issued in 2008, which could be either Heliophysics or Astrophysics missions depending on the proposals selected. Development of the Radiation Belt Storm Probes mission to study the interactions of space weather events with Earth's magnetic field is continuing for launch in 2012. The Magnetosphere Multi-Scale mission to observe the processes of magnetic reconnection, energetic particle acceleration, and turbulence in Earth's magnetosphere will undergo a Confirmation Review this year for a planned launch in 2014. Finally, NASA is continuing early formulation work on the Solar Probe-Plus mission that will travel into, and sample, the near-Sun environment to probe the origins of the solar wind.

Aeronautics Research

NASA's FY 2010 budget provides $507 million for Aeronautics Research. Over the past year, the Aeronautics Research Mission Directorate has continued to pursue long-term, innovative, and cutting-edge research that develops revolutionary tools, concepts, and technologies to enable a safer, more flexible, environmentally friendly, and more efficient national air transportation system. NASA Aeronautics Research also plays a vital role in supporting NASA's space exploration activities.

A primary goal across Aeronautics Research programs is to establish strong partnerships with industry, academia, and other government agencies in order to enable significant advancement in our Nation's aeronautical expertise. NASA has put many mechanisms in place to engage academia and industry, including industry working groups and technical interchange meetings at the program and project level, Space Act Agreements (SAAs) for cooperative partnerships, and the NASA Research Announcement (NRA) process that provides for full and open competition for the best and most promising research ideas. To date, 68 SAAs have been established with industry partners across all programs and 375 NRAs have been awarded to academia, industry and non-profit organizations. NASA Aeronautics has continued to collaborate with the Joint Planning Development Office (JPDO), Federal Aviation Administration (FAA), U.S. Air Force, Army, and other government organizations.

New for FY 2010, $62.4 million has been provided for the **Integrated Systems Research Program** (ISRP) to conduct research at an integrated system-level on promising concepts and technologies and explore, assess, or demonstrate the benefits in a relevant environment. The research in this program will be coordinated with on-going, long-term, foundational research within the three other research programs, and will be closely coordinated with other Federal Government agency efforts. The project within ISRP will be the Environmentally Responsible Aviation (ERA) Project, a "green aircraft initiative," that will explore and assess new vehicle concepts and enabling technologies through system-level experimentation to simultaneously reduce fuel burn, noise, and emissions. The ERA project will transfer knowledge outward to the aeronautics community so that aircraft and propulsion system manufacturers can confidently transition these technologies into new products, as well as transfer knowledge inward to the

Fundamental Aeronautics Program when the need for further development at a foundational level is identified.

NASA's **Airspace Systems** Program (ASP) has partnered with the JPDO to help develop concepts, capabilities and technologies that will lead to significant enhancements in the capacity, efficiency and flexibility of the National Airspace System. For FY 2010, ASP has been reorganized from the NextGen Airspace and NextGen Airportal projects into the NextGen Concepts and Technology Development project and the NextGen Systems Analysis, Integration and Evaluation project. The distinctions between airport operations, terminal-area operations and en-route operations were sometimes confusing, leading to time expended determining the line of demarcation between the responsibilities of the two projects. A more significant distinction is the development of air traffic management concepts and the technologies that enable air traffic management improvements and the evaluation of these concepts and technologies at a system level. The previously planned work on airspace concepts, technologies and systems will continue. This new project structure is better aligned to the nature of the work being performed. A notable accomplishment for ASP is the successful completion, by NASA researchers in collaboration with academia and the FAA, of a series of human-in-the-loop experiments that explored advanced concepts and technology for separation assurance, which ensures that aircraft maintain a safe distance from other aircraft, terrain, obstacles, and certain airspace not designated for routine air travel. The technology being developed by NASA and its partners is critical to relieving air-traffic controller workload, a primary constraint on airspace capacity that is expected to increase in coming years. In the future, this Program will continue to develop new technologies to solve important problems such as surface traffic planning and control, and initial algorithms for airport arrival and departure balancing as well as developing traffic flow management concepts for increased efficiencies at the regional and national levels for different planning intervals.

NASA's **Fundamental Aeronautics** Program (FAP) conducts research in all aeronautics disciplines that enable the design of vehicles that fly through any atmosphere at any speed. For FY 2010, all ARMD research into planetary entry, descent and landing (EDL) has been consolidated into the Hypersonics project in FAP. EDL is an integral part of many space missions and is not easily divided into distinct hypersonic and supersonic phases. This change will provide more focus to technical developments and will also yield technical management efficiencies. The FAP program has supported the testing of various new concepts that will help enable much improved capabilities for future vehicles. For example, wind-tunnel testing was conducted for several promising powered lift concepts. Powered lift concepts increase lifting force on an aircraft at slow speeds (e.g., at take-off and landing) without increasing drag under cruise conditions. Successful use of the concepts will enable short take-off and landings on runways less than 3000 feet, which will increase next-generation air transportation system capacity through the use of shorter fields and improved low-speed maneuverability in airport terminal areas. Testing was also completed for a Smart Material Actuated Rotor Technology (SMART) helicopter rotor, which offers the potential for significant noise and vibration reduction in rotorcraft. Future work includes technologies and advanced tools to evaluate the trades between noise, emissions, and performance of future aircraft entering service in the 2012-2015 timeframe. Additionally, with the transfer of technologies to be matured to system-level within ISRP, the Subsonic Fixed Wing (SFW) project is streamlining its research content. This is enabling new efficiencies across the foundational disciplines remaining in the project. The integrated system-level research in this program will be coordinated with on-going, long-term, foundational research within the three other research programs, and will focus specifically on maturing and integrating technologies in major vehicle systems and subsystems for accelerated transition to practical application.

NASA's **Aviation Safety** Program (AvSP) continues to develop tools and technologies to improve on today's incredibly safe air transportation system, while ensuring that future technologies can be safely incorporated to the system. Examples of advances that support this development include NASA's

ongoing and new research into aircraft icing. For example, with current knowledge we cannot extrapolate how ice forms on a straight wing such as found on a turbo-prop to how it will form on a swept wing, or a radically new aircraft configuration. The Aviation Safety Program is tackling this with a combination of computational models and experiments in NASA's Icing Research Tunnel. We are establishing that, in high and cold flight conditions, ice can form deeper in jet engines than previously understood. NASA is working collaboratively with the FAA, industry and international partners, such as the National Research Council of Canada, to conduct tunnel tests of the underlying physics, to fly our instrumented S-3 Viking into such engine icing conditions, and design upgrades to our Propulsion System Lab in which jet engines may be tested in detail. Additional future work in Aviation Safety includes addressing gaps in validation and verification of critical flight software, developing new data-analysis capabilities to mine aviation operational data for safety issues, examining the safety of new vehicle systems and structures, and tackling the biggest human factors issues in the NextGen flightdeck.

NASA's **Aeronautics Test Program** (ATP) is focused on ensuring a healthy suite of facilities and platforms to meet the nation's testing needs including the development of new test instrumentation and test technologies. As part of its continuous efforts to improve facility operational efficiencies, ATP initiated the National Force Measurement Technology Capability, to address the severe erosion of NASA's capability to utilize strain gage balances in wind tunnel testing. The National Partnership for Aeronautics Testing, a strategic partnership between NASA and the Department of Defense (DOD), recently commissioned a study of government-owned, mid-to-large supersonic facilities necessary to fulfill future air vehicle test requirements. The Program will continue to develop a long-term strategic approach that aligns the NASA and DOD facilities to meet future requirements with the right mix of facilities and appropriate investments in facility capabilities.

Exploration Systems

Human space flight is important to America's political, economic, technological and scientific leadership. In the span of a few short years, NASA has already taken long strides in the formulation of strategies and programs to develop a robust program of space exploration. These critical steps will allow our Nation to build the next-generation space flight vehicles that will carry humans and deliver cargo to the ISS and the Moon, and on to other destinations in our solar system. The President's FY 2010 budget request for Exploration Systems is $3,963.1 million, an increase of $457.6 million above the FY 2009 appropriation and $225.4 million above the planned FY 2010 level in last year's request. Based on the Recovery Act funds and the President's increased budget request for FY 2010, the Exploration Systems budget plan includes about $630 million more in FY 2009 and FY 2010 than the previous plan. At this critical juncture, full funding at the President's requested level is essential for expediting development of new U.S. human space flight systems to support the International Space Station and explore the Moon and other destinations beyond low Earth orbit.

The Constellation Program will apply additional Recovery Act funds to critical activities related to the successful completion of the Orion, Ares I and Ground Operations projects. The Commercial Crew and Cargo Program plans to use Recovery Act funds to stimulate efforts within the private sector in order to develop and demonstrate technologies that enable commercial human space flight capabilities – efforts that are intended to foster entrepreneurial activity leading to job growth in engineering, analysis, design, and research, and to economic growth as capabilities for new markets are created.

Following the Review of U.S. Human Space Flight activities, the Administration will provide an updated request for Exploration activities, as necessary. In the meantime, NASA is proceeding as planned with current Exploration activities, including Ares I, Orion, Commercial Crew and Cargo efforts, and lunar systems.

During the past year, NASA Exploration Systems continued to make significant progress in developing the next-generation U.S. human space flight vehicles and their associated ground and mission support systems. In the next several weeks, the first lunar robotic mission, the Lunar Reconnaissance Orbiter and the Lunar Crater Observation Sensing Satellite spacecraft, will be launched from the Cape Canaveral Air Force Station aboard an Atlas V, which will help NASA scout for potential lunar landing and outpost sites. Later this year, two major test flights for the Constellation Program will be conducted: Ares I-X is the first developmental test flight to support the design of the Ares I Crew Launch Vehicle; and the Pad Abort 1 (PA-1) is the first test of the Launch Abort System to be used on the Orion Crew Exploration Vehicle. NASA will continue to work with other nations and the commercial sector to coordinate planning, leverage investment, and identify opportunities for specific collaboration on Exploration activities.

The **Constellation** Program continues to complete the formulation phase of its projects – in particular Ares I, Orion, and major ground facilities. Major development work is underway, contracts are in place; and we have a dedicated group of civil servants and contractors who are all working hard to accomplish the Constellation Program's objectives. So far, NASA engineers have conducted about 6,500 hours of wind tunnel testing on subscale models of the Ares I to simulate how the current vehicle design performs in flight. These wind tunnel tests, as well as the Ares I-X test flight, will lay the groundwork for maturing the Ares I final design prior to its Critical Design Review (CDR). When launched later this year from NASA's Kennedy Space Center in Florida, the Ares I-X will climb about 25 miles in a two-minute powered test of the First Stage performance and the First Stage separation and parachute recovery system. Work on the Orion Project also continues to advance. Recently, NASA conducted testing of the water recovery process for the Orion capsule, and NASA also selected the material for Orion's heat shield. Later this year, Orion's PA-1 test will take place at White Sands Missile Range, New Mexico. PA-1 will demonstrate the Launch Abort System's ability to pull crew to safety should there be an emergency while the Orion and Ares I stack is still on the launch pad.

In September 2008, Ares I completed a key milestone with its Preliminary Design Review (PDR). PDR is the final step of the initial design process, and thereby a crucial milestone during which the overall project verifies that the preliminary design can meet all requirements within acceptable risk limits and within cost and schedule constraints, and identifies technical and management challenges and addresses approaches for eliminating or mitigating them. This fall, the Orion is expected to have progressed to the point of completing PDR, and obtaining Agency approval to proceed to Critical Design Review (CDR). Current plans call for Ares I to progress to the point of obtaining Agency approval by early 2010 to proceed to CDR.

As part of the Commercial Crew and Cargo Program and its associated Commercial Orbital Transportation Services (COTS) cargo projects, NASA is completing its promised $500 million investment to the two funded COTS partners, Space Exploration Technologies Corporation (SpaceX) of El Segundo, California, and Orbital Sciences Corporation (Orbital) of Dulles, Virginia. Recently, SpaceX successfully operated the full complement of the first stage engines of the Falcon 9, the SpaceX launch vehicle. Orbital continues to progress in achieving engineering milestones, and completed its PDR earlier this month. In addition, NASA has two non-funded COTS partners.

The transition of NASA facilities, infrastructure, property, and personnel from the Space Shuttle Program to the Constellation Program continues to be a major activity. This joint effort between the Space Operations and Exploration Systems Mission Directorates includes the utilization and disposition of resources, including real and personal property; personnel; and processes in order to leverage existing Shuttle and Space Station assets for NASA's future Exploration activities.

NASA's **Advanced Capabilities** programs include the Human Research Program (HRP) and the Exploration Technology Development Program (ETDP). These programs continue to reduce risks for human explorers of the Moon and beyond by conducting research and developing new technologies to aid future explorers. HRP focuses on the highest risks to crew health and performance during exploration missions while also developing and validating a suite of human health countermeasures to facilitate long-duration space travel. For example, NASA is conducting research to better understand the effect of space radiation on humans and to develop effective mitigation strategies. This year, HRP delivered a space radiation risk assessment tool, provided cockpit display design requirements for the Orion spacecraft, and provided design requirements for the new Constellation Space Suit System. HRP is also conducting research onboard the ISS with regard to: the cardiac structure and function of astronauts; radiation shielding technologies; and, the effect that certain pharmaceuticals may have on the prevention of bone loss during long-duration missions. ETDP will conduct a range of activities, including testing cryogenic hydrogen and methane propulsion systems for future missions; developing a small pressurized rover for transporting astronauts on the lunar surface; and demonstrating the capability to produce oxygen from lunar soil. ETDP also is conducting experiments on the Space Station to investigate the behavior of fluids and combustion in microgravity, and operating instruments to monitor atmospheric contaminants on the Space Station.

Space Operations

The FY 2010 budget request includes $6,175.6 million for Space Operations.

It is an exciting time for NASA's **Space Shuttle Program**. At this moment, the astronauts of Shuttle Atlantis are in orbit on STS-125, the final mission to service the Hubble Space Telescope. We anticipate that the work they are doing, which includes upgrading the Hubble's instruments, should extend the observatory's operational life several years. The President's FY 2010 budget funds the safe flight of the Space Shuttle to conduct its remaining missions, including the AMS flight and completing assembly of the ISS. NASA is committed to completing the eight remaining scheduled Shuttle flights, which we believe can be accomplished by the end of 2010. These Shuttle flights will leave the ISS in a configuration to support a broad portfolio of research and to receive and be maintained by commercial cargo services. The FY 2010 budget request includes $3,157.1 million for the Space Shuttle Program.

NASA and its Russian, European, Canadian, and Japanese **International Space Station** partners are working together to realize one of the most inspiring dreams of the last 50 years: the establishment of a station in Earth orbit for the conduct of various types of research. We are now approaching two significant milestones. In May, the ISS will host its first six-person crew. The recent delivery of the Station's final set of solar arrays and other equipment by the crew of STS-119 represents the final step toward this goal. In June, the STS-127 mission will deliver the third and final component of the Japanese *Kibo* laboratory -- the *Kibo* Exposed Facility. The addition of the Exposed facility enables the *Kibo* laboratory, with the European *Columbus* module and the U.S. *Destiny* module, to complete the three major international science labs on ISS, setting the stage for utilization of ISS as a highly capable microgravity research facility. The President's FY 2010 budget request includes $2,267.0 million for the ISS.

The ISS will represent both an unparalleled international cooperative effort and a U.S. National Laboratory in orbit. Scientists will be able to conduct biomedical and engineering research from a unique vantage point. Some of the work will increase our knowledge of the effects of long-duration human space flight, which is critical for the design and operation of future human space vehicles, including those being developed under the Constellation Program to return U.S. astronauts to the Moon and explore other destinations. Other research will not be focused on space exploration at all, but may have significant

applications right here on Earth. Medical research, for example, may be applicable to the development of vaccines; NASA's research into salmonella aboard the Space Shuttle and ISS has already increased our knowledge in this area. In the key areas of energy and the environment, the ISS serves as a daily demonstration of "green" technologies and environmental management techniques. The ISS receives 120kW of power from its solar arrays to operate the Station and run experiments. The ISS environmental system is designed to minimize the amount of mass that has to be launched from Earth to support the Station, so recycling is a must. STS-119 supplied ISS with a replacement Distillation Assembly for Station's water recycling system, which is key for supporting a full six-person crew for extended periods of time. Given the central role science and technology play in our society, it is important that the United States maintain a leadership role in these fields. The availability of a research laboratory in the microgravity environment of space will support this aim.

Another benefit from Space Shuttle missions and ISS research is reflected in the programs' ability to inspire the next generation of Americans. This was reflected recently in the delighted faces of students who participated in the uplinked phone call between President Obama and the crews of the ISS and STS-119 on March 24. The ISS will support the President's goal of making math and science education a national priority by demonstrating what can be accomplished through science and engineering, and by inspiring both teachers and students.

NASA is relying on U.S. industry to develop vehicles to deliver supplies and experiments to the ISS. In December 2008, the Agency awarded two Commercial Resupply Services (CRS) contracts for the provision of this critical capability. Cargo resupply is important for the continued viability of ISS. In addition, the vendors involved will gain valuable experience in the development and operation of vehicles that can 1) fly to the ISS orbit; 2) operate in close proximity to the ISS and other docked vehicles; 3) dock to ISS; and, 4) remain docked for extended periods of time.

The FY 2010 budget request includes $751.5 million for **Space and Flight Support**, which supports Space Communications and Navigation, Launch Services, Rocket Propulsion Testing, Crew Health and Safety, and the new Human Space Flight Operations programs.

Education

The FY 2010 budget request for Education totals $126.1 million and furthers NASA's commitment to Science, Technology, Engineering, and Mathematics (STEM) education. NASA will continue its successes in developing a future aerospace workforce, improving the technological competitiveness of our Nation's universities, attracting and retaining students in STEM disciplines, and engaging the public in NASA's missions. NASA will accomplish these goals by offering competitive research grants to universities, providing targeted educational support to Minority Serving Institutions, and strengthening curricula at two-year community colleges. NASA's plans to streamline and centralize internship and fellowship application processes will realize cost savings and facilitate student access to information while attracting a wider, more diverse participant base. The Agency is also seeking new opportunities for student involvement in current space and aeronautics research missions and flight projects, including those using high altitude balloons, sounding rocket payloads, airborne sensors, and space satellites. NASA will further these efforts through a new project, Innovation in STEM Education, which will allow the Agency to investigate and offer opportunities for student and faculty to participate in NASA-related research. In coming months, the Agency will complete award announcements for competitive grant programs in K-12, global climate change, and informal education, and revise and issue new solicitations using FY 2009 funds.

NASA will further pursue a goal to attract and retain students in STEM disciplines in the upcoming fiscal

year. Last year, the Interdisciplinary National Science Program Incorporating Research & Education (INSPIRE) program engaged over 200 high schools in STEM areas, and NASA Explorer Schools conducted instructional and enrichment activities that reached over 105,000 students. The March 2009 STS-119 mission also provided a unique educational opportunity as two Mission Specialists who are science teachers, Joe Acaba and Richard Arnold, were part of the crew. NASA Education continues to provide internships, fellowships, and research opportunities to help students and educators gain hands-on experiences in a range of STEM-related areas. These opportunities provide students with the motivation, inspiration, and experience needed to serve the Nation's current and future workforce needs. In FY 2008, the Agency provided more than 3,000 summer internships, reached 5,331 students through significant research experience or grants, and provided 139 grants to underrepresented and underserved institutions.

NASA will also engage elementary and secondary school and informal education audiences by using Earth and deep space observations, the flight experience of Educator Astronaut Dorothy Metcalf-Lindenburger aboard STS-131, as well as future missions to the Moon and other destinations. New technologies such as social networks, Internet collaborations, a new virtual magnet school, and remote control of science instruments will expand and enhance these efforts. In FY 2010, NASA also plans to provide an online professional development system for students training to become educators, in-service teachers, and informal educators. Additionally, NASA will promote continuous public awareness of its mission and improvement to STEM literacy by partnering with informal education providers, which allows Agency partners to share the excitement of NASA missions with their visitors in meaningful ways.

Cross-Agency Support

NASA Cross-Agency Support provides critical mission support activities that are necessary to ensure the efficient and effective operation and administration of the Agency, but cannot be directly aligned to a specific program or project requirement. These important functions align and sustain institutional and program capabilities to support NASA missions by leveraging resources to meet mission needs, establishing Agency-wide capabilities, and providing institutional checks and balances. Cross-Agency Support includes Center Management and Operations, Institutional Investments, and Agency Management and Operations. The FY 2010 budget request includes $3,400.6 million for Cross Agency Support.

Center Management and Operations funds the critical ongoing management, operations, and maintenance of nine NASA Centers and major component facilities. NASA Centers continue to provide high-quality support and the technical talent for the execution of programs and projects. The FY 2010 budget request includes $2.084 million for Center Management and Operations.

Institutional Investments funds design and execution of non-programmatic revitalization construction of facilities projects, demolition projects for closed facilities, and environmental compliance and restoration activities. The Construction of Facilities Program makes capital repairs and improvements to NASA's critical infrastructure to improve safety and security and improve NASA's operating efficiency by reducing utility usage. NASA continues to right size the infrastructure by demolishing facilities that are no longer needed. Emphasis has been placed on energy and water conservation. Currently, NASA has five buildings that are certified under the Leadership in Energy and Environmental Design (LEED) criteria, three additional buildings that are built and awaiting certification as LEED Silver facilities, and 13 buildings in various stages of design and construction as High Performance Buildings and are expected to be LEED-certified when completed. The FY 2010 budget request includes $355.4 million for Institutional Investments.

NASA's FY 2010 request includes $961.2 million for **Agency Management and Operations**, which funds the critical management and oversight of Agency missions, programs and functions, and performance of NASA-wide activities, including five programs: Agency Management, Safety and Mission Success, Agency Information Technology Services, Innovative Partnerships Program, and Strategic Capabilities Assets Program.

- The FY 2010 budget request provides $412.7 million for **Agency Management**, which supports executive-based, Agency-level functional and administrative management requirements. Agency Management provides for the operational costs of Headquarters as an installation; institutional and management requirements for multiple Agency functions; assessment and evaluation of NASA program and mission performance; strategic planning; and independent technical assessments of Agency programs.

- The FY 2010 budget request provides $183.9 million for **Safety and Mission Success** activities required to continue strengthening the workforce, training, and strengthening the fundamental and robust cross-checks applied on the execution of NASA's mission, and to improve the likelihood for safety and mission success for NASA's programs, projects, and operations. The engineering, safety and mission assurance, health and medical independent oversight, and technical authority components are essential to NASA's success and were established or modified in direct response to many of the key *Challenger* and *Columbia* accident board recommendations for reducing the likelihood for future accidents. Included under Safety and Mission Success is the Software Independent Verification and Validation program.

- The FY 2010 budget request for **Agency Information Technology Services** is $150.4 million, which encompasses cross-cutting services and initiatives in IT management, applications, and infrastructure necessary to enable the NASA Mission and improve security, integration and efficiency of Agency operations. NASA plans significant emphasis on continued implementation of five major Agency-wide procurements to achieve the following: (1) consolidation of IT networks leading to improved network management, (2) consolidation of desktop/laptop computer services and mobile devices to improve end-user services, (3) data center consolidation to provide more cost-effective services, (4) Agency public web site management to improve access to NASA data and information by the public, and (5) Agency business systems development and maintenance to provide more efficient and effective business systems. NASA will also continue to improve security incident detection, response, and management through the Security Operations Center.

- The request for the **Innovative Partnerships Program** (IPP) is $184.8 million. IPP works with all four Mission Directorates to provide innovations meeting NASA's technology needs, and transfers NASA technology for broad Spinoff applications that improve quality of life and contribute to economic growth. Included in the IPP portfolio are: NASA's SBIR/STTR Programs seeking out innovative high-technology small businesses; a new Innovative Technology Project seeking high-impact revolutionary research and technology projects; a Seed Fund to address technology needs through cost-shared, joint-development partnerships; use of commercial flight services by the FAST program to demonstrate new technologies; Innovation Ambassadors to exchange ideas; and the Centennial Challenges prize program for the citizen inventor. IPP seeks partnerships through offices at all 10 NASA Centers.

- Finally, NASA is requesting $29.4 million in FY 2010 for the **Strategic Capabilities Assets Program** (SCAP). This program funds the costs required to sustain key Agency test capabilities and assets, such as an array of flight simulators, thermal vacuum chambers, and arc jets, to ensure mission success. SCAP ensures that assets and capabilities deemed vital to NASA's current and future success are sustained in order to serve Agency and national needs. All assets and capabilities identified for

sustainment either have validated mission requirements or have been identified as potentially required for future missions.

Conclusion

The President's FY 2010 budget request for NASA supports the Administration's commitment to deploy a global climate change research and monitoring system, funds a robust program of space exploration involving humans and robots with a goal to return Americans to the Moon by 2020 and explore other destinations, and funds the safe flight of the Shuttle to complete assembly of the ISS through its retirement, planned for the end of 2010. The FY 2010 budget request funds continued use of the ISS to enable the Agency to develop, test, and validate critical exploration technologies and processes and, in coordination with our international partners, to make the ISS available support other government entities, commercial industry and academic institutions to conduct unique research in the microgravity environment of space. It will also stimulate private sector development and demonstration of vehicles that may support NASA's cargo and crew requirements. And it renews NASA's commitment to aeronautics research to address fundamental aeronautics, aviation safety, air traffic management, and mitigating the impact of aviation on the environment. NASA's diverse portfolio of science, technology, engineering and mathematics (STEM) educational activities is also aligned with the Administration's goal of improving American innovation and global competitiveness. NASA looks forward to working with the Committee on implementation of the detailed FY 2010 budget request.

Mr. Chairman, thank you for your support and that of this Committee. I would be pleased to respond to any questions you or the other Members of the Committee may have.

National Aeronautics and Space Administration
President's FY 2010 Budget Request Summary

Budget Authority, $ in million By Appropriation Account By Theme	FY 2008 Actuals	FY 2009 Enacted	Recovery Act	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
Science	**4,733.2**	**4,503.0**	**400.0**	**4,477.2**	**4,747.4**	**4,890.9**	**5,069.0**	**5,185.4**
Earth Science	1,237.4	1,379.6	325.0	1,405.0	1,500.0	1,550.0	1,600.0	1,650.0
Planetary Science	1,312.6	1,325.6		1,346.2	1,500.6	1,577.7	1,600.0	1,633.2
Astrophysics	1,395.6	1,206.2	75.0	1,120.9	1,074.1	1,042.7	1,126.3	1,139.6
Heliophysics	787.6	591.6		605.0	672.6	720.5	742.7	762.6
Aeronautics	**511.4**	**500.0**	**150.0**	**507.0**	**514.0**	**521.0**	**529.0**	**536.0**
Exploration	**3,299.4**	**3,505.5**	**400.0**	**3,963.1***	**6,076.6***	**6,028.5***	**5,966.5***	**6,195.3***
Constellation Systems	2675.9	3033.2	400.0	3505.4	5543.3	5472.0	5407.6	5602.6
Advanced Capabilities	623.5	472.3		457.7	533.3	556.5	558.9	592.7
Space Operations	**5,427.2**	**5,764.7**	**0.0**	**6,175.6**	**3,663.8**	**3,485.3**	**3,318.6**	**3,154.8**
Space Shuttle	3,295.4	2,981.7		3.157.1	382.8	87.8	0.0	0.0
International Space Station	1,685.5	2,060.2		2,267.0	2,548.2	2,651.6	2,568.9	2,405.9
Space and Flight Support	446.2	722.8		751.5	732.7	745.9	749.7	748.9
Education	**146.8**	**169.2**	**0.0**	**126.1**	**123.8**	**123.8**	**123.8**	**125.5**
Education	146.8	169.2		126.1	123.8	123.8	123.8	125.5
Cross-Agency Support	**3,251.4**	**3,306.4**	**50.0**	**3,400.6**	**3,468.4**	**3,525.7**	**3,561.4**	**3,621.4**
Center Management and Operations	2,011.7	2,024.0		2,084.0	2,119.2	2,142.5	2,166.1	2,189.9
Agency Management and Operations	834.1	921.2		961.2	956.9	964.5	972.3	981.5
Institutional Investments	325.5	293.7	50.0	355.4	392.3	418.7	423.0	450.0
Congressionally Directed Items	80.0	67.5		0.0	0.0	0.0	0.0	0.0
Inspector General	**32.6**	**33.6**	**2.0**	**36.4**	**37.0**	**37.8**	**38.7**	**39.6**
NASA FY 2010	**17,401.9**	**17,782.4**	**1,002.0**	**18,686.0**	**18,631.0**	**18,613.0**	**18,607.0**	**18,858.0**
Year to Year Change		2.2%		5.1%	-0.3%	-0.1%	0.0%	1.3%

**** Following the human spaceflight review, the Administration will provide an updated request for Exploration activities reflecting the review's results.***