

Statement of
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before the
House Science Committee

Mr. Chairman and Members of the Committee, thank you for this opportunity to appear today to discuss NASA's commitment to maintaining robust Earth and space science programs and their contributions to achieving the nation's *Vision for Space Exploration*.

The Science Mission Directorate provides leadership to NASA at the Agency level, delivering a unique scientific perspective. The Earth and space science activities of the Science Mission Directorate fully support NASA's mission to:

- Understand and Protect our Home Planet by using our view from space to study the Earth system and improve prediction of Earth system change
- Explore the Universe and Search for Life by continuing scientific investigations into the origin, evolution, and destiny of the universe and our solar system, and by applying our scientific understanding of the Earth system to the identification and study of Earth-like planets around other stars
- Inspire the Next Generation of Explorers by providing Earth and Space science content and training to educators, and by sponsoring the education and early careers of Earth scientists, astronomers, and physicists.

On January 14, 2004, President George W. Bush announced the *Vision for Space Exploration*. The President's directive gave NASA a new focus and clear objectives. The fundamental goal of this directive for the Nation's space exploration program is "...to advance U.S. scientific security, and economic interests through a robust space exploration program." In issuing this directive, the President committed the Nation to a journey of returning humans to the Moon, sending robots and ultimately humans to Mars, and exploring the solar system and beyond. He challenged us to establish new and innovative programs to enhance our understanding of the planets, to ask new questions and to answer questions as old as humankind. NASA enthusiastically embraced this directive and immediately began an agency-wide transformation to enable us to achieve the *Vision*.

NASA's recently published document, *The New Age of Exploration: NASA's Direction for 2005 and Beyond*, articulates NASA's commitment to implementing the *Vision for Space Exploration*. It identifies NASA's Guiding National Objectives to:

1. Implement a sustained and affordable human and robotic program to explore the solar system and beyond
2. Extend human presence across the solar system, starting with the Moon by the year 2020, in preparation for human exploration of Mars and other destinations
3. Develop innovative technologies, knowledge, and infrastructure both to explore and to support decisions about the destinations for human exploration
4. Promote international and commercial participation in exploration
5. Study the Earth System from space and develop new space-based and related capabilities for this purpose

NASA Earth science is critical for fulfilling NASA's mission because of NASA's unique capabilities of frequent global observations, modeling and data assimilation with the aim to improve prediction of both large-scale and small-scale processes. Human exploration of Mars and beyond requires prediction of the environment to be encountered by humans. The technological tools and scientific skills that NASA continues to develop through studying Earth, which has the most complex ecosystem with continuous interactions of biological, chemical and physical processes at all time and space scales, are critical in the exploration and search for life of other planets in our own solar system and beyond.

In June 2004, the President's Commission on the Implementation of the United States Space Exploration Policy, led by E.C. "Pete" Aldridge, Jr. (the Aldridge Commission), and reported their findings and recommendations to the President. The Aldridge Commission emphasized the crucial roles that technological innovation, national and international partnerships, and organizational transformation must play if we are to implement the President's *Vision* for an affordable and sustainable space exploration program. NASA is committed to making the necessary transformation to ensure our success in achieving the *Vision* for an affordable and sustainable space exploration program.

The Historic Opportunity to Implement the *Vision*

The transformation presents NASA's science endeavors with an historic opportunity to support and benefit from the *Vision for Space Exploration*. As the National Research Council stated in their report, *Science in NASA's Vision for Space Exploration (2005)*, "the appropriate science in a vibrant space program is nothing less than that science that will transform our understanding of the universe around us, and will in time transform us into a space-faring civilization that extends human presence across the solar system."

In August 2004, NASA repositioned its science endeavors by merging two science Enterprises into one Science Mission Directorate with three themes: Earth-Sun System, Solar System Exploration, and Universe. The merger of Space Science, with its emphasis on "discovery", and Earth Science's capacity for "prediction" positions the Science Mission Directorate to support the *Vision* by engaging in comprehensive scientific investigations into the Origin, Evolution, and Destiny of the Earth, the Solar System, and the Universe. The synergies facilitated by this integration will benefit research, development, and improve science results in all NASA science disciplines, including Earth science. Furthermore, a unified Science Mission Directorate facilitates the opportunity for all of the discipline areas of science to learn from each other which, in turn, enhances NASA's exploration activities.

Planning for the Future

NASA has identified eighteen strategic objectives, from which thirteen strategic roadmaps will be derived. Six of these roadmaps directly apply to the activities and research objectives of the Science Mission Directorate. The current strategic planning process forms the basis for our future strategy for Earth and space science. Through our actions, we are clearly emphasizing a continuing commitment to Earth science and NASA's commitment to study the Earth system is clearly reflected in our national objectives. Not only will these studies better inform our work as we implement the *Vision*, but will strengthen our ability to continue to support Presidential initiatives involving climate change science and technology, the oceans, an integrated Earth observation system, and others.

Strategic Roadmapping

While the “Aldridge” Commission provided the blueprint for NASA’s ongoing transformation in support of the *Vision*, NASA’s strategic planning efforts are defining the specific details for *The New Age of Exploration*. New strategic roadmaps will provide a foundation for future investment decisions and priorities in 13 key areas. Each strategic roadmap is being developed by a team composed of nationally-recognized scientists, engineers, educators, visionaries, and managers, organized into dedicated teams co-chaired by senior NASA leaders and nationally recognized leaders from industry and academia. In some strategic roadmap areas, thematic roadmaps already exist or are in development. These “legacy” products and activities will be integrated into the new process.

The Dynamic Earth System roadmap committee submitted its interim status report to NASA for review on April 15. The work being done by this roadmapping committee has already identified a number of missions that NASA should consider in the future. For Earth Science, the roadmap assumes the successful implementation of the currently planned mission set, such as the Orbiting Carbon Observatory, Aquarius, and the Global Precipitation Measurement missions. Likewise, for the Sun-Earth Connection, the roadmap assumes the successful implementation of STEREO, Solar-B, Magnetosphere Multi-Scale, Radiation Belt Storm Probes, and the Solar Dynamics Observatory missions.

In addition, the Dynamic Earth System and Sun-Solar System Connection roadmap committees are coordinating their activities and held a joint meeting on March 16, 2005. Interim reports from the two committees evidence interest in similar missions. Such missions have considerable importance for Earth science and the *Vision for Space Exploration* by enabling high-temporal resolution of atmospheric changes and solar influences on climate, and by providing a capability to monitor space weather and solar events that could be hazardous to spacecraft and astronauts.

Unlike the other roadmap committees, the Dynamic Earth System committee did not have the benefit of a National Research Council Decadal Survey as a starting input; such a survey was requested shortly before the roadmapping activity began and is currently in work. NASA expects to receive the final Phase II report by the end of calendar year 2006. However, the Dynamic Earth System committee will benefit from other detailed, strategic planning documents from NASA and national planning processes such as the U.S. Climate Change Science Plan, the Grand Challenges for Natural Disaster Reduction, and the U.S Integrated Earth Observation System.

We have recently received the Dynamic Earth System committee’s draft report and are pleased with the Committee’s products and progress. We appreciate their hard work and support and value their contributions to this critical endeavor.

Decadal Study

At the request of NASA and NOAA, the National Research Council is carrying out a “decadal survey” entitled “Earth Science and Applications from Space: A Community Assessment and Strategy for the Future”. The Space Studies Board, in consultation with other units of the NRC, will lead the study to generate consensus recommendations from the Earth and environmental science and applications communities regarding a systems approach to space-based and ancillary observations that encompasses the research programs of NASA and the related operational programs of NOAA.

The key goals of the study are:

- Articulate priorities for Earth system science and the space-based observational approaches to address those priorities.
- Establish individual plans and priorities within the sub-disciplines of the Earth sciences as well as an integrated vision and plan for the Earth sciences as a whole.

Providing Continued Leadership while Leveraging Partnerships in Earth Sciences

Presidential Initiatives

The FY06 budget supports critical national needs, including climate change by supporting investments in the U.S. Global Change Science and Technology Programs and next generation Earth observing satellites.

In addition to supporting the Vision for Space Exploration, NASA's Earth science program has a critical role in implementing important Administration initiatives:

- Global Earth Observation System of Systems via the U.S. Group on Earth Observations - The purpose of GEOSS is to achieve comprehensive, coordinated and sustained observations of the Earth system, in order to improve monitoring of the state of the Earth, increase understanding of Earth processes, and enhance prediction of the behavior of the Earth system. NASA's Earth Observing System supports this effort through a series of polar-orbiting and low inclination satellites, a science component, and a data system of long-term global observations of the land surface, biosphere, solid Earth, atmosphere, and oceans.
- Climate Change Science Program - NASA's Earth science program is the largest contributor (over 60 percent of the total funding) to the Administration's Climate Change Science Program. NASA brings the global perspective from satellite and suborbital measurements to address climate and global change science questions. NASA has the end-to-end capability to develop technologies, models, deploy observing systems and utilize and provide products for decision support systems.
- Grand Challenges in Natural Disaster Reduction - NASA research and observations are essential to help the U.S. meet its disaster reduction goals for the next decade. Through its ability to view the earth as a dynamic system, NASA makes key contributions to the science of hazard assessment and mitigation and provides essential support to the efforts of other Federal agencies charged with these responsibilities.

International Partnerships

NASA has long-standing relationships with foreign countries in the conduct of Earth science. Historically, over 50 percent of NASA's Earth science programs have involved international participation. Such partnerships have allowed each country to leverage their Earth science resources to conduct outstanding science in the pursuit of understanding our Earth and the forces that influence its change. Cloudsat and CALIPSO, scheduled to launch this summer, exemplify how NASA is able to successfully collaborate with space agencies around the world. NASA and the Canadian Space Agency worked together to develop CloudSat's Cloud Profiling Radar. For CALIPSO, CNES, the French space agency, not only provided the spacecraft and the Imaging Infrared Radiometer (IIR), but is also performing payload-to-spacecraft integration and spacecraft mission operations.

In support of the *Vision for U.S. Space Exploration*, the Science Mission Directorate held a conference this past March that included participation from 26 international organizations. In some cases the participants were representatives from multilateral organizations such as the Central American Commission on Environment and Development (CCAD), the European Commission (EC), and the United Nations Educational, Scientific and Cultural Organization (UNESCO). The conference provided a forum for NASA and its international partners to exchange information on the *Vision* and to discuss opportunities for enhanced future cooperation. A recurring theme at the conference was the importance of international collaboration and information sharing in achieving common scientific priorities.

Interagency Partnerships

NASA works closely with our partner agencies on national programs including the Climate Change Science Program, the Grand Challenges in Disaster Reduction, and Integrated Earth Observation System. We value our long history of collaboration with research agencies, such as NSF and DOE, as well as operational agencies, such as EPA, USDA, DOI and NOAA. We are committed to continuing to work closely with our partner agencies to ensure the continuity of datasets crucial to our nation.

NASA and the U.S. Geological Survey (USGS) of the Department of Interior have cooperated to produce new global land cover data products for each of three different time periods: the 1970s, circa 1990, and circa 2000. The DOI (USGS) and NASA share responsibility for preserving and populating the National Satellite Land Remote Sensing Data Archive and ensuring the continued collection of Landsat data. The Landsat Program is the longest running enterprise for acquisition of imagery of the Earth from space. The first Landsat satellite was launched in 1972 and the most recent, Landsat 7, was launched in 1999. USGS's 33-year Landsat data archive provided most of the over 20,000 Landsat satellite images needed. In partnership with private industry (the Earth Satellite Corporation), the GeoCover product was created. Researchers, planners, and land managers are now using the GeoCover data to understand how the Earth's land cover and land use have changed over the past thirty years. Recent projects have documented urbanization in the U.S. and tracked land cover change on the biologically rich island of Madagascar. A new project is underway to map changes in North American forests since 1975 as part of the North American Carbon Program. GeoCover data also have been made available through two United Nations organizations, the UN Environment Programme (UNEP) and the Food and Agriculture Organization (FAO).

NOAA, NASA, US Navy and US Air Force jointly support the Joint Center for Satellite Data Assimilation (JCSDA) which seeks to accelerate and improve the quantitative use of research and operational satellite data in weather and climate prediction models. Recent successes have been based on data from a number of NASA satellites, including QuikSCAT, TRMM, Terra and Aqua. Through the JCSDA, inclusion of NASA data on sea winds, rainfall, high latitude winds and temperature and humidity vertical profiles in NOAA forecast models has led to improved NOAA weather forecast models, including short-term, hurricane and seasonal-to-inter-annual forecasts. The JCSDA helps to transform NASA's results into NOAA's operational systems and we are working together to ensure that each agency's models are sufficiently similar to allow for easy movement of progress from one to the other.

NASA and NOAA have also worked together to improve weather prediction on Earth Through a long-standing relationship where NASA acts as a program manager and purchasing agent on NOAA's behalf. This relationship in developing, launching, and operating the GOES and POES satellites has provided invaluable information used every day to forecast the weather, both in the U.S. and across the world. The launch of NASA-built NOAA N later this year will provide new short- and long-range forecasting capabilities.

In 1970, NASA's Nimbus-4 satellite led to the first measurements of global ozone content from space. Beginning with the Nimbus-7 in 1979, NASA and NOAA have harnessed this capability through the Total Ozone Mapping Spectrometers (TOMS) and the Solar Backscatter Ultraviolet (SBUV) instruments to produce a continuous 25-year data record of global ozone. The resulting long-term data set has been a central part of international assessments of the state of the ozone layer, showing both the global picture and trend of ozone loss and the progress of the Antarctic ozone hole. The continued data from this series of satellites will also play a key role in the observation of the recovery of the ozone layer. To interweave data from this series of satellite instruments into a homogenous climate-quality data record requires the ongoing commitment of this interagency science team. This data record, and the blending of diverse strengths to analyze and verify data, continues today with the advanced ozone measurements being made by NASA's Aura mission. This capability will transition to NPOESS, with the first flight of the OMPS instrument suite aboard the NASA NPP mission.

More recently, NASA and NOAA have begun cooperating on missions related to space weather and its effects on Earth. Data from NASA spacecraft can be used to improve the NOAA capability to predict space weather. For example, NOAA uses data from NASA's solar wind monitoring ACE spacecraft to assist in predicting space weather. New NASA instruments will continue to inform the process needed to further develop a robust operational capability to predict space weather. By working together, NASA and NOAA are jointly able to answer questions of interest to both agencies: "How and why the Sun varies?"; "How does the Earth respond to solar variability?"; and "What are the implications of solar variability and the Earth's response?"

Based on this synergy of science objectives and history of coordination and cooperation, NASA has been working with NOAA to transition to a strategy that better leverages our respective strengths in science investigations and mission operations. NASA believes this is in line with the principles of good and efficient management of public funds to serve our Nation and the world. It is our intent to continue to work with NOAA to look for new ways to improve the efficiency of these transfers. For example, both agencies have jointly funded a study by the National Academy of Sciences/National Research Council Committee on NASA-NOAA Transition from Research to Operations (CONNTRO). The May 2003 final report was called "*Satellite Observations of the Earth's Environment, Accelerating the Transition from Research to Operations.*" In addition, NASA and NOAA have established a Joint Research to Operations (R2O) Working Group as a mechanism for joint and coordinated planning on transition matters pertaining to research results, ground systems, and current and future spacecraft missions in preparation for discussions within the National Science and Technology Council.

FY2006 Budget

The former Earth Science Enterprise and the Sun-Earth Connection theme from the former Space Science Enterprise have been combined to form the new Earth-Sun System theme. In this new theme, the following programs can be traced from Earth Science: Earth Systematic Missions, Applications and Earth System Pathfinders.

The FY 2006 budget supports a vibrant and effective science program that is responsive to national priorities. The overall NASA science programs budget runout shows a 24 percent increase from FY 2006 through FY 2010, at which time science will grow from 33 percent to approximately 38 percent of the NASA budget. NASA's Science Mission Directorate continues to support 55 operational missions, 26 missions in development and 34 in formulation. There are 16 Earth Science missions presently on orbit and plans to launch 8 more Earth Science missions between 2005 and 2010. Earth science missions in development include Cloudsat; the Cloud-Aerosol Lidar and Infrared Pathfinder (CALIPSO); the NPOESS Preparatory Project (NPP); the Orbiting Carbon Observatory (OCO); and the Landsat Data Continuity Mission (LDMC). In addition, the following Earth science missions are currently in formulation: the Ocean Surface Topography Mission (OSTM); the Global Precipitation Mission (GPM); Glory; Aquarius; and Hydros. Additionally, the NOAA reimbursable missions GOES-N, O, and P and POES-N and N' are in development and GOES-R is in formulation.

One of NASA's Strategic Objectives for 2005 and beyond is to advance scientific knowledge of the Earth system through space-based observation, assimilation of new observations, and development and deployment of enabling technologies, systems, and capabilities including those with the potential to improve future operational systems. The FY 2006 budget for NASA supports a highly effective program of research and development of Earth Sciences, and plans are now being formulated to continue this significant effort into the future.

Conclusion

The integrated view of Sun and Earth as a system is reflected in our strategic roadmapping approach and long-term planning. NASA's goal is to continue using our unique view from space to study the Earth system and improve our prediction of the Earth system change. Through new space-based technology designed to monitor the Earth system, NASA will provide timely, on-demand data and analyses to users for scientific research, national policymaking, economic growth, natural hazard mitigation, and the exploration of other planets in this solar system and beyond. NASA's FY 2006 budget request supports a robust science and mission set to ensure a wealth of scientific research and discovery will continue well into the future. Through this approach we also recognize the emerging importance of understanding the Earth-Sun system in enabling the achievement of the *Vision* and NASA's exploration mandate.