Introduction

NASA's Science Mission Directorate (SMD) conducts scientific exploration enabled by the use of space observatories and probes that view the Earth from space, observe and visit other bodies in the solar system, and gaze out into our galaxy and beyond. NASA's science program seeks answers to profound questions that touch us all:

- How and why are Earth’s climate and the environment changing?
- How and why does the Sun vary and affect Earth and the rest of the solar system?
- How do planets and life originate?
- How does the universe work, and what are its origin and destiny?
- Are we alone?

From space, in space, and about space, NASA’s science vision encompasses questions as practical as cause and course of hurricanes, as enticing as the prospect of life on other worlds, and as profound as the origin of the Universe. The innovative space missions described in this document will help us answer those questions. NASA operates over 50 missions in space and has over 25 more in preparation for launch over the next decade. Some are strategic missions identified in decadal surveys from the National Academy of Sciences or created to meet national or agency objectives. Others are competed missions selected in response to open solicitations. About half involve partnerships with other US government agencies or the space agencies of our international partners. All these missions are challenging endeavors that stretch our scientific and technological capacity, enhance our economic competitiveness, and enrich the education and training of the next generation of scientists and engineers.

Within each science area, the missions are grouped first by those now in orbit and those in development. Within those two categories, the missions are listed alphabetically.
Advance Earth System Science to meet the challenges of climate and environmental change.

NASA pioneered the interdisciplinary field of Earth System Science—the study of the Earth as an integrated system. This approach to studying the Earth as a single complex system is essential to understanding the causes and consequences of climate change and other global environmental concerns. Spaceborne instruments provide essential broad coverage, high spatial resolution, frequent sampling, and near-uniform accuracy and stability. Multiple on-orbit missions, including those flying in coordinated orbits as part of planned constellations, allow data to be acquired simultaneously on many important quantities, enabling investigations of the interactions among the coupled Earth processes that constitute the climate system. NASA's research, coupled with that of our partners in the U.S. Global Change Research Program, provides much of the nation's knowledge base for understanding, mitigating, and adapting to climate change.
ACRIMSAT
Active Cavity Radiometer Irradiance Monitor

Launch Date: December 20, 1999
Phase: Extended

The ACRIMSAT spacecraft carries an instrument which measures the Sun’s total energy output, continuing a data set started in 1980. ACRIMSAT data can be correlated with data on global temperature, ice cap and sea ice extent, and ozone concentrations.

Aqua

Launch Date: May 04, 2002
Phase: Extended
Partners: Japan and Brazil
Web site: http://aqua.nasa.gov

Aqua was launched with six state-of-the-art instruments to observe the Earth’s oceans, atmosphere, land, ice and snow covers, and vegetation, providing high measurement accuracy, spatial detail, and temporal frequency.

Aquarius

Launch Date: June 10, 2011
Phase: Prime
Partner: Argentina
Web site: http://aquarius.gsfc.nasa.gov

By measuring sea surface salinity over the globe with such unprecedented precision, Aquarius will answer long-standing questions about how our oceans respond to climate change and the water cycle. Monthly sea surface salinity maps will give clues about changes in freshwater input and output to the ocean associated with precipitation, evaporation, ice melting, and river runoff.
Aura

Launch Date: July 15, 2004  
Phase: Extended  
Partners: The Netherlands and the United Kingdom  
Web site: http://aura.gsfc.nasa.gov

Aura’s objective is to study the chemistry and dynamics of the Earth’s atmosphere with emphasis on the upper troposphere and lower stratosphere (0–30 km) by employing multiple instruments on a single satellite. Each instrument makes daily global observations of Earth’s atmospheric ozone layer, air quality, and key climate parameters.

CALIPSO  
Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations

Launch Date: April 28, 2006  
Phase: Extended  
Partner: France  
Web site: http://www-calipso.larc.nasa.gov

CALIPSO combines an active lidar with passive infrared and visible imagers to study the role clouds and aerosols (airborne particles) play in weather, climate and air quality.

CloudSat

Launch Date: April 28, 2006  
Phase: Extended  
Partner: Canada  
Web site: http://cloudsat.atmos.colostate.edu

CloudSat provides a comprehensive characterization of the structure and composition of clouds and their effects on climate under all weather conditions using an advanced cloud profiling radar.
Earth Observing-1 (NMP)

Launch Date: November 21, 2000
Phase: Extended
Web site: http://eo1.gsfc.nasa.gov

Earth Observing-1 (EO-1) is an advanced land-imaging mission that demonstrates new instruments and spacecraft systems. The hyperspectral instrument called Hyperion is the first of its kind to provide images of land-surface in more than 220 spectral colors.

GRACE
Gravity Recovery and Climate Experiment

Launch Date: March 17, 2002
Phase: Extended
Partner: Germany
Web site: http://www.csr.utexas.edu/grace

The GRACE mission accurately maps variations in the Earth’s gravity field. GRACE data is used to estimate global models for the variable Earth gravity field approximately every 30 days, and reveals changes in levels of large underground aquifers.

Jason-1

Launch Date: December 07, 2001
Phase: Extended
Partner: France

Jason is an oceanography mission to monitor global ocean circulation, improve global climate predictions, and monitor events such as El Niño conditions and ocean eddies. The mission helps increase understanding of ocean circulation and seasonal changes and improve forecasting of climate events like El Niño.
Landsat 7
Launch Date: April 15, 1999
Phase: Extended
Partner: USGS
Web site: http://ls7pm3.gsfc.nasa.gov

Landsat 7 is a joint mission of NASA and USGS to gather Earth resource data, and is the most recent in a long series of Landsat satellites going back over 35 years to 1974.

Suomi-NPP
National Polar-Orbiting Partnership
Launch Date: October 25, 2011
Phase: Prime
Partners: NOAA
Web site: http://jointmission.gsfc.nasa.gov

Suomi-NPP is the bridge between the EOS satellites and the forthcoming series of Joint Polar Satellite System (JPSS) satellites. Suomi-NPP data are being used for climate research and operational weather prediction.

OSTM/Jason 2
Ocean Surface Topography Mission/Jason 2
Launch Date: June 20, 2008
Phase: Extended
Partners: The European Organization for the Exploitation of Meteorological Satellites (EUMETSAT), France and NOAA

OSTM/Jason 2 measures sea surface height by using a radar altimeter mounted on a low-Earth orbiting satellite. Measurements of sea-surface height, or ocean surface topography, reveal the speed and direction of ocean currents and tell scientists how much of the sun’s energy is stored by the ocean.
**QuikSCAT**

**Quick Scatterometer**

Launch Date: June 19, 1999  
Phase: Extended  

The SeaWinds instrument on the QuikSCAT satellite is a specialized microwave radar that measures near-surface wind speed and direction under all weather and cloud conditions over Earth’s oceans. Having exceeded its design life by 8 years, QuikSCAT now serves as a transfer standard to calibrate other satellites.

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**SORCE**

**Solar Radiation and Climate Experiment**

Launch Date: January 25, 2003  
Phase: Extended  
Web site: http://lasp.colorado.edu/sorce

SORCE provides state-of-the-art measurements of incoming x-ray, ultraviolet, visible, near-infrared, and total solar radiation. The measurements specifically address long-term climate change, natural variability and enhanced climate prediction, and atmospheric ozone and UV-B radiation.

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**Terra**

**Launch Date:** December 18, 1999  
Phase: Extended  
Partner: Canada  
Web site: http://terra.nasa.gov

Terra simultaneously studies clouds, water vapor, aerosol particles, trace gases, terrestrial and oceanic surface properties, biological productivity of the land and oceans, Earth’s radiant energy balance, the interaction among them, and their effects on climate.
TRMM
Tropical Rainfall Measuring Mission

Launch Date: November 27, 1997
Phase: Extended
Partner: Japan
Web site: http://trmm.gsfc.nasa.gov

The first-time use of both active and passive microwave instruments have made TRMM the world’s foremost satellite for the study of precipitation and associated storms and climate processes in the tropics.

FUTURE MISSIONS

ASCENDS
Active Sensing of CO₂ Emissions over Nights, Days and Seasons

Launch Date: NET 2020
Phase: Pre-formulation

ASCENDS will measure the total column abundance of carbon dioxide (CO₂) with precision and accuracy sufficient to improve understanding of sources and sinks. Use of a laser system will allow it to observe both day and night.

CLARREO
Climate Absolute Radiance & Refractivity Observatory

Launch Date: NET 2022
Phase: Pre-formulation
Partner: NOAA
Web site: http://clarreo.larc.nasa.gov

CLARREO’s measurements will provide a long-term benchmarking data record for the detection, projection, and attribution of changes in the climate system. In addition, these measurements will provide a source of absolute calibration for a wide range of visible and infrared Earth observing sensors, greatly increasing their value for climate monitoring.
DESDynI
Deformation Ecosystem Structure & Dynamics of Ice

Launch Date: NET 2021
Phase: Pre-formulation

DESDynI will monitor surface deformation to improve understanding of earthquakes, volcanoes, and landslides. DESDynI data will be useful for managing our ground water resources, and for understanding the response of ice sheets, glaciers, and sea ice to climate change.

Earth Venture 2

Launch Date: 2017
Phase: Pre-formulation

EV-2 will be the first of the Venture-class of competed small satellites missions. The first solicitation for complete missions was issued in 2011 with selection in 2012. The Venture class program also includes separate solicitations for instruments of opportunity and for airborne science investigations.

GPM
Global Precipitation Measurement

Launch Date: June 2014
Phase: Development
Partner: Japan

GPM is an international constellation of satellites designed to provide global precipitation observations every 2 to 4 hours. The GPM concept centers a “Core” observatory carrying advanced active and passive microwave sensors to measure precipitation and serve as a calibration reference to unify and refine precipitation estimates from a constellation of research and operational satellites.
GRACE-FO
Gravity Recovery and Climate Experiment Follow-On

Launch Date: 2017
Phase: Formulation
Partner: Germany

This mission will provide continuity of measurements of Earth’s gravity field as a follow-on to the original GRACE mission, launched in March 2002, until the more capable Tier 3 NRC Decadal Survey GRACE-II mission can be developed.

ICESat II
Ice, Cloud, and land Elevation Satellite II

Launch Date: 2016
Phase: Formulation

The ICESat-II mission will deploy an ICESat follow-on satellite to continue the assessment of polar ice changes by providing multi-year elevation data needed to determine ice sheet mass balance as well as cloud property information, especially for stratospheric clouds which are common over polar areas.

LDCM
Landsat Data Continuity Mission

Launch Date: June 2013
Phase: Development
Partner: USGS
Web site: http://ldcm.nasa.gov

LDCM will provide moderate-resolution (15m–100m, depending on spectral frequency) measurements of the Earth’s terrestrial and polar regions in the visible, near-infrared, short wave infrared, and thermal infrared. LDCM will provide continuity with the 38-year long Landsat land imaging data set. In addition to widespread routine use for land use planning and monitoring on regional to local scales, support of disaster response and evaluations, and water use monitoring.
OCO-2  
Orbiting Carbon Observatory-2  
Launch Date: 2015  
Phase: Development  
OCO-2 will provide the first complete picture of human and natural carbon dioxide sources and sinks by mapping their global geographic distribution studying their changes over time. The OCO-2 spacecraft will replace OCO-1, lost during a launch vehicle failure in 2009.

PACE  
Pre-Aerosol, Clouds, and Ecosystem Mission  
Launch Date: 2020  
Phase: Pre-Formulation  
PACE will make global ocean color measurements essential for understanding the carbon cycle and polarimetry measurements to provide extended data records on clouds and aerosols initially provided by the PARASOL mission.

SAGE-III  
Stratospheric Aerosol and Gas Experiment-III  
Launch Date: 2014  
Phase: Formulation  
SAGE-III will continue critical long-term measurements of the vertical structure of aerosols, ozone, water vapor, and other important trace gases in the upper troposphere and stratosphere. SAGE-III will be attached payload on the ISS.
SMAP
Soil Moisture Active-Passive

Launch Date: 2015
Phase: Formulation

The SMAP mission will provide direct measurement of surface soil moisture and freeze-thaw state. Direct measurements of these properties are necessary to improve our understanding of regional water cycles, ecosystem productivity, and processes that link the water, energy, and carbon cycles.

SWOT
Surface Water Ocean Topography

Launch Date: 2020
Phase: Pre-formulation

The SWOT mission brings together two communities focused on a better understanding of the world’s oceans and its terrestrial surface waters. The SWOT satellite mission with its wide-swath altimetry technology is a means of completely covering the world’s oceans and freshwater bodies with repeated high-resolution elevation measurements.
Joint Agency Satellite Division (JASD)

NASA established the Joint Agency Satellite Division (JASD) in March 2010 within SMD to manage NASA’s fully reimbursable satellite and instrument development program, which currently includes NOAA and USGS-funded missions.

JASD’s primary focus is on efficiently managing operational satellite projects, particularly across multiple acquisitions. A large part of this efficiency arises from the integrated, permanent structural presence within NASA Headquarters that JASD provides.

JASD can engage partner agencies early in the Federal Government planning process, support those agencies in their engagements with OSTP, OMB and Congress, and offer the agencies a single interface for development and management of their satellite projects.
**Jason 3**

Launch Date: 2014  
Phase: Formulation  
Partner: Reimbursable NOAA partnership. NOAA partners on this project with EUMETSAT and CNES.

Transition the measurement of ocean surface topography to the operational suite of polar-orbiting weather satellites.

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**JPSS-1**  
Joint Polar Satellite System 1

Launch Date: 2017  
Phase: Formulation  
Partner: Reimbursable NOAA partnership. NOAA partners on this project with EUMETSAT and JAXA.

Provide data continuity for global environmental data used in numerical weather prediction models, climate modeling, and space weather observations.

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**JPSS-2**  
Joint Polar Satellite System 2

Launch Date: 2021  
Phase: Formulation  
Partner: Reimbursable NOAA partnership. NOAA partners on this project with EUMETSAT and JAXA.

Provide data continuity for global environmental data used in numerical weather prediction models, climate modeling, and space weather observations.
GOES-R
Geostationary Operational Environmental Satellite-R

Launch Date: 2015
Phase: Formulation
Partner: Reimbursable NOAA partnership

Provide geosynchronous environmental monitoring with greater resolution and coverage, the first geo-orbiting lightning mapper and increased capability to detect space weather and solar events.

GOES-S
Geostationary Operational Environmental Satellite-S

Launch Date: 2016
Phase: Formulation
Partner: Reimbursable NOAA partnership

Provide geosynchronous environmental monitoring with greater resolution and coverage, the first geo-orbiting lightning mapper and increased capability to detect space weather and solar events.
Understand the Sun and its interactions with the Earth and the solar system.

Our planet is immersed in a seemingly invisible yet exotic and inherently hostile environment. Above the protective cocoon of Earth’s atmosphere is a plasma soup composed of electrified and magnetized matter entwined with penetrating radiation and energetic particles. Our Sun’s energy output, which varies on time scales from milliseconds to billions of years, forms an immense structure of complex magnetic fields. Inflated by the solar wind, this colossal bubble of magnetism, known as the heliosphere, stretches far beyond the orbit of Pluto. This extended atmosphere of the Sun drives some of the greatest changes in our local space environment—affecting our magnetosphere, ionosphere, atmosphere, and potentially our climate. Heliophysics is the study of these interactions through-out the region of space influenced by the Sun.
ACE
Advanced Composition Explorer

Launch Date: August 27, 1997
Phase: Extended
Location: Earth-Sun L1
Partner: NOAA and USAF
Web site: http://www.srl.caltech.edu/ACE

ACE observes particles of solar, interplanetary, interstellar and galactic origins. ACE's solar wind observations are used on an operational basis for space weather forecasting by both NOAA and USAF.

AIM
Aeronomy of Ice in the Mesosphere

Launch Date: April 25, 2007
Phase: Extended
Location: Earth Orbit

Explore Polar Mesospheric Clouds (PMCs), which form an icy membrane at the edge of Earth’s atmosphere, to find out why they form and why they are changing.

CINDI/CNOFS
Coupled Ion-Neutral Dynamics Investigation

Launch Date: April 16, 2008
Phase: Extended
Location: Earth Orbit
Partner: USAF
Web site: http://www.nasa.gov/mission_pages/cindi

This was selected as a Mission of Opportunity to discover the role of ion-neutral interactions in the generation of small and large-scale electric fields in the Earth’s upper atmosphere.
Cluster-II

Launch Date: July 16, 2000
Phase: Extended
Location: Polar Earth Orbit
Partner: European Space Agency

Cluster II conducts an in-situ investigation of the Earth's magnetosphere using four identical spacecraft simultaneously, allowing the determination of three-dimensional and time-varying phenomena and the differences between spatial and temporal variations.

Geotail

Launch Date: July 24, 1992
Phase: Extended
Location: Elliptical Earth Orbit
Partner: Japan

Study the dynamics of the Earth's magnetotail over a wide range of distance and measure global energy flow and transformation in the magnetotail.

IBEX

Interstellar Boundary Explorer

Launch Date: October 19, 2008
Phase: Extended
Location: Elliptical Earth Orbit
Partner: Switzerland
Web site: http://ibex.swri.edu

IBEX measures energetic neutral atoms created at the boundary that separates our heliosphere from the local interstellar medium.
RHESSI
Reuven Ramaty High Energy Solar Spectroscope Imager

Launch Date: February 5, 2002
Phase: Extended
Location: Earth Orbit
Web site: http://hesperia.gsfc.nasa.gov/hessi

Advance our understanding of the fundamental high-energy processes at the core of the solar flare problem by imaging flares and obtaining a detailed energy spectrum at each point of the image.

SOHO
Solar and Heliospheric Observatory

Launch Date: December 2, 1995
Phase: Extended
Location: Earth-Sun L1
Partner: European Space Agency
Web site: http://sohowww.nascom.nasa.gov

Study the internal structure of the Sun, its extensive outer atmosphere and the origin of the solar wind in tandem with ESA’s two related solar observatories.

Solar-B/Hinode

Launch Date: September 23, 2006
Phase: Extended
Location: Sun Synchronous Orbit
Partners: Japan and the United Kingdom
Web site: http://solarb.msfc.nasa.gov

Japan’s Hinode mission uses a three-instrument suite to understand how energy generated by magnetic-field changes in the photosphere is transmitted to the corona, how that energy influences the dynamics and structure of the corona, and how the energy transfer and atmospheric dynamics affects the interplanetary-space environment.
**SDO**
Solar Dynamics Observatory

**Launch Date:** February 11, 2010  
**Phase:** Prime  
**Location:** Geosynchronous  
**Web site:** http://sdo.gsfc.nasa.gov

SDO studies how solar activity is created and how space weather results from that activity by measuring the sun’s interior, magnetic field, the hot plasma of the solar corona, and the irradiance.

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**STEREO**
Solar Terrestrial Relations Observatory

**Launch Date:** October 25, 2006  
**Phase:** Extended  
**Location:** Sun Synchronous Orbit

Trace the flow of energy and matter from the Sun to Earth with two space-based observatories, as well as reveal the 3D structure of coronal mass ejections and the reasons why they happen.

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**THEMIS**
Time History of Events and Macroscale Interactions during Substorms

**Launch Date:** February 17, 2007  
**Phase:** Extended  
**Location:** Earth Orbit  
**Partners:** Canada, Germany, France and Austria  

THEMIS originally used five identically instrumented spacecraft to answer fundamental questions concerning the nature of the substorm instabilities that abruptly and explosively release solar wind energy stored within the Earth’s magnetotail. Two of the five THEMIS spacecraft have been re-purposed as the ARTEMIS mission to study the space weather environment around the Moon.
TIMED
Thermosphere, Ionosphere, Mesosphere
Energetics and Dynamics

Launch Date: December 7, 2001
Phase: Extended
Location: Earth Orbit
Web site: http://www.timed.jhuapl.edu/WWW/index.php

Explore the Earth’s Mesosphere and Lower Thermosphere (60–180 kilometers up), understand the energy transfer into and out these regions and the basic structure that results from the energy transfer into the region.

TWINS A & B
Two Wide-Angle Imaging Neutral-Atom Spectrometers

Launch Date: A-June 2006, B-March 13, 2008
Phase: Extended
Location: Earth Orbit (Molniya)
Partner: USAF
Web site: http://twins.swri.edu/index.jsp

TWINS enables the 3-dimensional visualization and the resolution of large scale structures and dynamics within the magnetosphere by imaging the charge exchange of neutral atoms over a broad energy range using two identical instruments on two widely spaced high-altitude, high-inclination spacecraft.

Voyager

Launch Date: August and September 1977
Phase: Extended
Location: Heliosheath

Voyagers 1 and 2 conducted close-up studies of Jupiter and Saturn, Saturn’s rings, and the larger moons of the two planets as well as study the outer planets and beyond. Voyager 1 is now at the extreme edge of our solar system, exploring its interface with the interstellar medium.
Wind

Launch Date: November 1, 1994  
Phase: Extended  
Location: Earth-Sun L1  
Partners: Part of the Global Geospace Science (GGS) initiative, which is part of the worldwide International Solar-Terrestrial Physics (ISTP) collaboration.  
Web site: http://wind.nasa.gov

This mission measures crucial properties of the solar wind before it impacts the Earth’s magnetic field and alters the Earth’s space environment.

FUTURE MISSIONS

IRIS
Interface Region Imaging Spectrograph

Launch Date: June 2013  
Phase: Development  
Location: Sun-synchronous  

Increase our understanding of energy transport into the corona and solar wind and provide an archetype for all stellar atmospheres by tracing the flow of energy and plasma through the chromosphere and transition region into the corona using spectrometry and imaging.

LWS SET-1
Living With a Star Space Environment Testbed-1

Launch Date: January 2014  
Phase: Development  
Location: Earth Orbit  
Partners: United Kingdom and France  
Web site: http://lws.gsfc.nasa.gov

Improve the engineering approach to accommodate and / or mitigate the effects of solar variability on spacecraft design and operations.
MMS
Magnetospheric MultiScale Mission

Launch Date: March 2015
Phase: Development
Location: Earth Orbit
Partners: Austria, France, Japan and Sweden
Web site: http://mms.gsfc.nasa.gov

Four identically instrumented spacecraft that will use Earth’s magnetosphere as a laboratory to study the microphysics of three fundamental plasma processes: magnetic reconnection, energetic particle acceleration, and turbulence.

RBSP
Radiation Belt Storm Probes

Launch Date: September 2012
Phase: Development
Location: Earth Orbit (Elliptical)
Partner: Czech Republic
Web site: http://rbsp.jhuapl.edu

RBSP will use two identical spacecraft in elliptical orbits to provide an understanding, ideally to the point of predictability, of how populations of relativistic electrons and penetrating ions in space form or change in response to variable inputs of energy from the Sun.

Solar Orbiter Collaboration

Launch Date: 2017
Phase: Formulation
Location: Sun Orbit
Partner: European Space Agency-led
Web site: http://www.esa.int/esaSC/120384_index_0_m.html

This mission will study the Sun from a distance closer than any spacecraft previously has and provide images and measurements in unprecedented resolution and detail.
Solar Probe Plus

Launch Date: 2018
Phase: Formulation
Location: Sun Orbit
Web site: http://solarprobe.gsfc.nasa.gov

Repeatedly sample the near-Sun environment and make direct, in-situ measurements, revolutionizing our knowledge and understanding of coronal heating and the origin and evolution of the solar wind and allowing us to characterize and forecast the surrounding radiation environment.
Ascertain the content, origin, and evolution of the solar system, and the potential for life elsewhere.

NASA is at the leading edge of a journey of scientific discovery that will yield a profound new understanding of our solar system. Robotic exploration is the current approach to planetary science and is the necessary precursor to the expansion of humanity beyond Earth. NASA’s Planetary Science program pursues a strategy of surveying the planetary bodies of interest and targeting for repeated visits those likely to enable greatest progress toward answering the above science questions. For selected planetary bodies, successive visits progress from fly-by missions, to orbiters, to landers and entry probes, to rovers, to sample return missions. Underlying this strategy are the science themes of comparative planetology and habitability—the capacity of an environment (which pertain to an entire planet) to harbor life in the past, present, or future.
ARTEMIS
Acceleration, Reconnection, Turbulence and Electrodynamics of the Moon’s Interaction with the Sun

Launch Date: Repurposed in-orbit (THEMIS in 2007)
Phase: Prime
Web site: http://www.nasa.gov/mission_pages/artemis

The ARTEMIS mission uses two of the five in-orbit spacecraft from a Heliophysics constellation of satellites, THEMIS, that were launched in 2007 and successfully completed their mission in 2010. The ARTEMIS mission operates those two spacecraft at Earth–Moon L1 and L2.

Cassini

Launch Date: October 15, 1997
Phase: Extended
Partners: European Space Agency and Italy

Cassini arrived at Saturn in 2004 and completed its first extended mission in Sept. 2010, and it is seeking to make exciting new discoveries in a second extended mission called the Cassini Solstice Mission through Sept. 2017. The second extension will allow for the first study of a complete seasonal period. (A Saturn year is 30 Earth years).

Dawn

Launch Date: September 27, 2007
Phase: Prime

Dawn’s goal is to characterize the conditions and processes of the solar system’s earliest epoch by investigating in detail two of the largest protoplanets remaining intact since their formations. Ceres and Vesta reside in the extensive zone between Mars and Jupiter.
Deep Impact/EPOXI
Extrasolar Planet Observation and Deep Impact Extended Investigation

Launch Date: January 12, 2005
Phase: Extended
Web site: http://epoxi.umd.edu

EPOXI is the supplemental mission of NASA's Deep Impact spacecraft. EPOXI is the flyby spacecraft that is to explore other celestial targets of opportunity such as Hartley 2. EPOXI made its closest approach to Hartley 2 on November 4, 2010.

GRAIL (Ebb and Flow)
Gravity Recovery And Interior Laboratory

Launch Date: September 10, 2011
Phase: Prime
Web site: http://grail.nasa.gov

GRAIL's primary science objectives are to determine the structure of the lunar interior, from crust to core and to advance understanding of the thermal evolution of the Moon. Also, analysis of GRAIL data will extend knowledge gained from the Moon to the other terrestrial planets.

Juno

Launch Date: August 5, 2011
Phase: Prime
Arrival: at Jupiter in 2016
Partners: Belgium and Italy
Web site: www.nasa.gov/juno

Juno will improve our understanding of our solar system’s beginnings by revealing the origin and evolution of Jupiter. Juno will also look deep into Jupiter’s atmosphere to measure composition, temperature, cloud motions and other properties. Juno is a New Frontiers mission.
LRO
Lunar Reconnaissance Orbiter

Launch Date: June 17, 2009
Phase: Prime
Web site: http://lro.gsfc.nasa.gov

LRO aims to identify lunar sites that are close to potential resources and have high scientific value, favorable terrain, and the environment necessary for safe future robotic and human lunar missions.

Mars Odyssey

Launch Date: April 7, 2001
Phase: Extended
Web site: http://mars.jpl.nasa.gov/odyssey

Mars Odyssey globally mapped the amount and distribution of many chemical elements and minerals that make up the martian surface. Maps of hydrogen distribution led scientists to discover vast amounts of water ice in the polar regions buried just beneath the surface.

MESSENGER
Mercury Surface, Space Environment, Geochemistry and Ranging

Launch Date: August 3, 2004
Phase: Prime
Mercury Orbit Insertion: March 17, 2011
Web site: http://messenger.jhuapl.edu

MESSENGER will image all of Mercury for the first time, as well as gather data on the composition and structure of Mercury’s crust, its geologic history, the nature of its active magnetosphere and thin atmosphere, and the makeup of its core and the materials near its poles. By studying Mercury, NASA researchers expect to understand how our own Earth was formed.
**MSL**

*Mars Science Laboratory*

*Launch Date:* November 26, 2011  
*Phase:* Prime  
*Partners:* Canada, France, Germany, Spain and Russia  

MSL’s Curiosity rover will assess whether Mars ever was, or is still today, an environment able to support microbial life. That is, MSL’s mission is to determine the planet’s “habitability.” MSL, the largest rover ever sent to Mars, is scheduled to arrive on the Martian surface in August 2012.

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**MRO**

*Mars Reconnaissance Orbiter*

*Launch Date:* August 12, 2005  
*Phase:* Extended  
*Partner:* Italy  

Mars Reconnaissance Orbiter is providing new information in unprecedented detail about the surface, subsurface, and atmosphere of Mars. MRO imagery is used to characterize potential landing sites for other missions including the Mars Science Laboratory. MRO has detected evidence that water persisted on the surface of Mars for a long period of time, and is examining whether underground martian ice discovered by Mars Odyssey is the top layer of a deep ice deposit or a shallow layer in equilibrium with the atmosphere and its seasonal cycle.

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**New Horizons**

*Launch Date:* January 19, 2006  
*Phase:* Prime  
*Arrival at Pluto:* 2015  
*Web site:* [http://pluto.jhuapl.edu](http://pluto.jhuapl.edu)

New Horizons is designed to help us understand worlds at the edge of our solar system by making the first reconnaissance of Pluto and Charon, and one or more Kuiper Belt objectives beyond, to reveal the origin and evolution of our planetary neighbors. New Horizons is a New Frontiers mission.
Opportunity
Mars Exploration Rover

Launch Date: July 7, 2003
Phase: Extended
Partner: Germany
Web site: http://marsrovers.nasa.gov

Opportunity performs on-site geological investigations on Mars. Its mission is to search for and characterize a wide range of rocks and soils that hold clues to past water activity on Mars. Now in the seventh year of a 90-day mission, Opportunity is poised to explore the giant crater Endeavor.

FUTURE MISSIONS

LADEE
Lunar Atmosphere and Dust Environment Explorer

Launch Date: November 2013
Phase: Development
Web site: http://science.nasa.gov/missions/ladee

LADEE will orbit the Moon and its main objective is to characterize the atmosphere and lunar dust environment. LADEE aims to determine the global density, composition, and time variability of the fragile lunar atmosphere before it is perturbed by further surface exploration activity.

MAVEN
Mars Atmosphere and Volatile Evolution

Launch Date: October 2013
Phase: Development
Partner: France
Web site: http://science.nasa.gov/missions/maven

MAVEN will explore the planet’s upper atmosphere, ionosphere and interactions with the sun and solar wind. MAVEN data can determine the loss of volatile compounds—such as carbon dioxide, nitrogen dioxide, and water—from the Mars atmosphere to space has played through time.
**OSIRIS-Rex**
Origins-Spectral Interpretation-Resource Identification-Security-Regolith Explorer

**Launch Date:** September 2016  
**Arrival:** 2020  
**Return:** 2023  
**Phase:** Development

After traveling four years, OSIRIS-REx will approach the primitive, near Earth asteroid designated 1999 RQ36 in 2020. Once within three miles of the asteroid, the spacecraft will begin six months of comprehensive surface mapping. The science team then will pick a location from where the spacecraft’s arm will take a sample. The spacecraft gradually will move closer to the site, and the arm will extend to collect more than two ounces of material for return to Earth.

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**Strofio**

**Launch Date:** 2014  
**Phase:** Development  
**Partner:** ESA  
**Web site:** [http://discovery.nasa.gov/strofio.cfml](http://discovery.nasa.gov/strofio.cfml)

Strofio is a unique mass spectrometer that is part a suite of instruments that will fly on board the European Space Agency’s BepiColombo/Mercury Planetary Orbiter (MPO) spacecraft. Strofio will determine the chemical composition of Mercury’s surface, providing a powerful tool to study the planet’s geological history.
Astrophysics

Discover how the universe works, explore how the universe began and developed into its present form, and search for Earth-like planets.

The science goals of Astrophysics are breathtaking: we seek to understand the universe and our place in it. We are starting to investigate the very moment of creation of the universe and are close to learning the full history of stars and galaxies. We are discovering how planetary systems form and how environments hospitable for life develop. The Physics of the Cosmos Program contains missions that can explore the most extreme physical conditions of the universe, from black holes to dark energy. The Cosmic Origins Program comprises projects that enable the study of how stars and galaxies came into being, how they evolve, and ultimately how they end their lives. The Exoplanet Exploration Program seeks to advance our understanding of planets and planetary systems around other stars, to detect Earth-like planets around other stars, to determine how common such planets are, and to search for indicators of life.
Chandra

Launch Date: July 23, 2009  
Phase: Extended  
Orbit Type: Earth Orbit, Apogee (133,000 km) and perigee (16,000 km)  
Partner: Germany  
Web site: http://chandra.harvard.edu/about

Chandra is a telescope specially designed to detect X-ray emission from very hot regions of the Universe such as exploded stars, clusters of galaxies, and matter around black holes.

Fermi
Fermi Gamma-ray Space Telescope

Launch Date: June 11, 2008  
Phase: Prime  
Orbit Type: Earth Circular Orbit  
Partners: DOE and International Team  
Web site: http://fermi.gsfc.nasa.gov

Fermi is a gamma-ray observatory. With Fermi, astronomers have a superior tool to study how black holes, notorious for pulling matter in, can accelerate jets of gas outward at fantastic speeds. Physicists can study subatomic particles at energies far greater than those seen in ground-based particle accelerators.

Herschel

Launch Date: May 14, 2009  
Phase: Prime  
Orbit Type: Sun-Earth L2  
Partners: European Space Agency, United Kingdom, Netherlands  

Herschel is an European Space Agency space-based telescope that will study the Universe by the light of the far-infrared and submillimeter portions of the spectrum. NASA provided key technologies to two of Herschel’s three detector instruments. Herschel is expected to reveal new information about the earliest, most distant stars and galaxies, as well as those closer to home in space and time.
Hubble Space Telescope

Launch Date: April 24, 1990  
Phase: Prime  
Orbit Type: Near-circular Low Earth Orbit  
Partner: European Space Agency  
Web site: http://hubble.nasa.gov

HST has provided astronomers a uniquely clear and deep view of the cosmos since the 1990s in the visible, ultraviolet, and infrared portions of the spectrum. HST has detected several atomic constituents in the atmosphere of a planet outside our solar system and places elsewhere in the Universe where the conditions for life exist.

INTEGRAL
International Gamma-Ray Astrophysics Laboratory

Launch Date: October 17, 2002  
Phase: Operating  
Orbit Type: Elliptical Earth orbit  
Partners: ESA, Russia, Czech Republic, and Poland  
Web site: http://heasarc.nasa.gov/docs/integral/integral.html

INTEGRAL is an ESA-led gamma-ray mission to study the most violent and exotic objects of the Universe, such as black holes, neutron stars, active galactic nuclei and supernovae. INTEGRAL is also helping us to understand processes such as the formation of new chemical elements and mysterious gamma-ray bursts, the most energetic phenomena in the Universe.

Planck

Launch Date: May 14, 2009  
Phase: Extended  
Orbit Type: Sun-Earth L2  
Partners: European Space Agency, ASI, CNES, United Kingdom  
Web site: http://sci.esa.int/science-e/www/area/index.cfm?fareaid=17

Planck is an European Space Agency mission using microwave detectors to address some of the most fundamental questions in cosmology. NASA provided the cooler system that enables Planck to reach its operating temperature of only 17° above absolute zero. Planck will tell us about the geometry and contents of the universe, how the universe grew after its birth, and how it evolved into structures we see today.
SOFIA  
Stratospheric Observatory for Infrared Astronomy  

First Science Flight: November 30, 2010  
Partner: Germany  
Web site: http://www.sofia.usra.edu/index.html  

SOFIA is the largest airborne observatory in the world, and will make observations that are impossible for even the largest and highest of ground-based telescopes. SOFIA will be used to study many different kinds of astronomical objects and phenomena such as star birth and death. SOFIA is a modified a 747-SP based at DFRC. SOFIA is still in development, with early science flights ongoing and full capability to be achieved in 2014.

Spitzer Space Telescope  

Launch Date: August 25, 2003  
Phase: Extended  
Orbit Type: Heliocentric Orbit  
Web site: http://science.nasa.gov/missions/spitzer  

During its cryogenic mission, Spitzer obtained images and spectra by objects in space between infrared wavelengths of 3 and 180 microns. Spitzer’s highly sensitive instruments provide scientists a unique view of the Universe and to look into regions of space that are hidden from optical telescopes.

Swift  

Launch Date: November 20, 2004  
Phase: Extended  
Orbit Type: Earth Orbit  
Partners: Italy, Science and Technology Facilities Council (formerly the Particle Physics and Astronomy Research Council), United Kingdom  

Swift is a multi-wavelength observatory dedicated to the study of gamma-ray burst (GRB) science. Swift’s three instruments have worked together to observe GRBs and afterglows in the gamma ray, X-ray, ultraviolet, and optical wavebands.
Suzaku

Launch Date: July 10, 2005  
Phase: Extended  
Partner: Japan  

Japan’s Suzaku satellite provides scientists with information to study these events in the X-ray energy range. Suzaku carries a new type of X-ray spectrometer, which will provide for the first time high resolution (allowing scientists to see much finer detail in the spectrum). NASA provided one of Suzaku’s three instruments.

XMM-Newton

X-ray Multi-Mirror Mission

Launch Date: December 10, 1999  
Phase: Extended  
Orbit Type: Elliptical Orbit  
Partner: European Space Agency  
Web site: http://science.nasa.gov/missions/xmm-newton

ESA’s XMM-Newton has helped scientists to solve a number of cosmic mysteries, ranging from the enigmatic black holes to the origins of the Universe itself. XMM-Newton is a telescope that can detect and study celestial X-ray sources. NASA provided elements of XMM-Newton’s instrument package.

FUTURE MISSIONS

Astro-H

Launch Date: February 2014  
Phase: Development  
Orbit Type: Earth Circular Orbit  
Partner: Japan  
Web site: http://heasarc.nasa.gov/docs/astroh

Japan’s Astro-H is a facility-class mission that aims to: (a) trace the growth history of the largest structures in the Universe, (b) provide insights into the behavior of material in extreme gravitational fields, (c) determine the spin of black holes, and (d) investigate the detailed physics of jets. NASA is collaborating with JAXA on the Soft X-ray Spectrometer (SXS) instrument.
GEMS
The Gravity and Extreme Magnetism SMEX

Launch Date: November 2014
Phase: Formulation
Orbit Type: Earth Circular Orbit
Web site: http://heasarc.nasa.gov/docs/gems

GEMS will use two grazing incidence X-ray optics to explore the shape of space that has been distorted by a spinning black hole’s gravity, and probe the structure and effects of the magnetic field around neutron stars. GEMS will use a new technique to measure the polarization of X-rays. GEMS is a small Explorer mission.

JWST
James Webb Space Telescope

Launch Date: 2018
Orbit Type: Earth-Sun L2
Phase: Development
Partners: European Space Agency and Canada
Web site: http://www.jwst.nasa.gov

James Webb Space Telescope (JWST) is a large, infrared-optimized space telescope. JWST will find the first galaxies that formed in the early Universe. JWST will peer through dusty clouds to see stars forming planetary systems, connecting star formation in our own galaxy with the Solar System.

NuSTAR
Nuclear Spectroscopic Telescope Array

Launch Date: March 2012
Phase: Development
Orbit type: Earth Orbit
Partner: Denmark
Web site: http://www.nustar.caltech.edu

NuSTAR will allow astronomers to study the universe in high energy X-rays. NuSTAR will be the first focusing hard X-ray telescope to orbit Earth and is expected to greatly exceed the performance of the largest ground-based observatories that have observed the electromagnetic spectrum region. NuSTAR is a small Explorer mission.
ST-7
Space Technology 7

Launch Date: April 2014
Phase: Development
Partner: ESA
Web site: http://nmp.jpl.nasa.gov/st7

Space Technology 7’s Disturbance Reduction System will fly onboard the European Space Agency’s (ESA) LISA Pathfinder mission. Space Technology 7 will flight test the Disturbance Reduction System, demonstrating that a solid body can float freely in space completely undisturbed. ST-7 is an essential step in the process to determine whether NASA and ESA will proceed with the Large Interferometer Space Antenna (LISA).