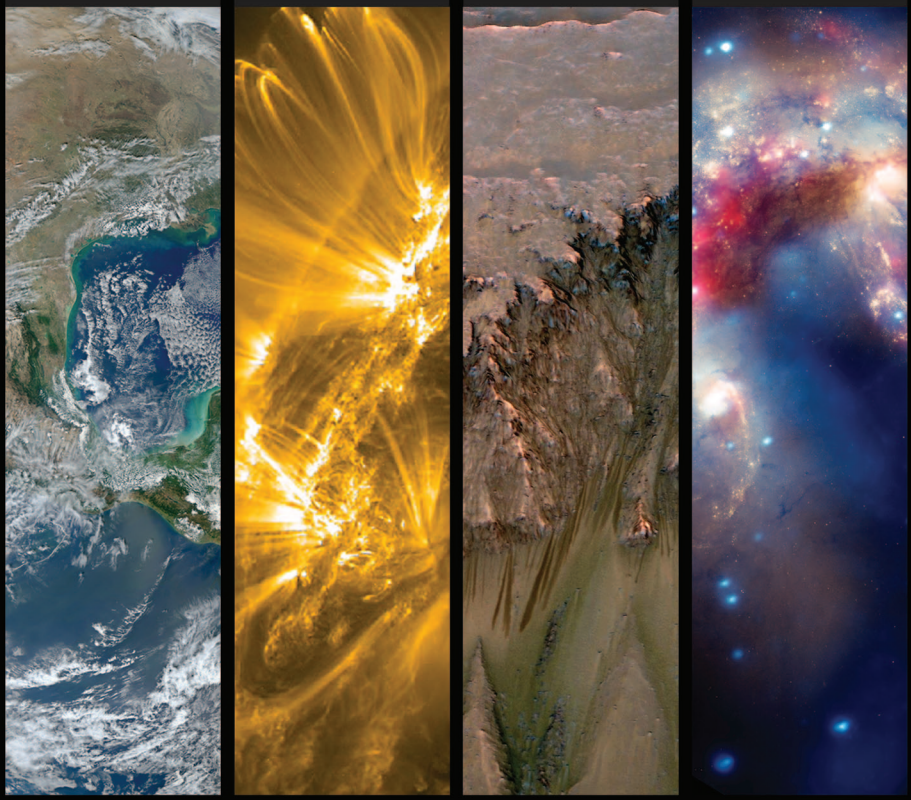
National Aeronautics and Space Administration



EARTH SCIENCE | HELIOPHYSICS | PLANETARY SCIENCE | ASTROPHYSICS

SMD MISSION HANDBOOK

www.nasa.gov

November 2012

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?

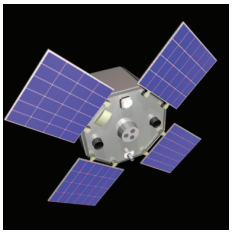
From space, in space, and about space, NASA's science vision encompasses questions as practical as cause and course of hurricanes, as enticing as the prospect of life on other worlds, and as profound as the origin of the Universe. The innovative space missions described in this document will help us 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.

Earth Science

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.

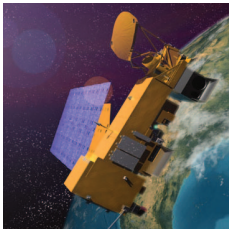


ACRIMSAT

Active Cavity Radiometer Irradiance Monitor

Launch Date: December 20, 1999
Phase: Extended
Web site: http://acrim.jpl.nasa.gov

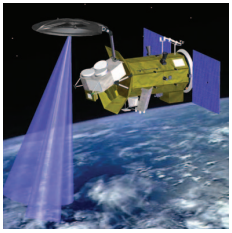
The ACRIMSAT spacecraft carries an instrument which measures the Sun's total energy output, continuing a data set started in 1980. ACRIMSAT data can be correlated with data on global temperature, ice cap and sea ice extent, and ozone concentrations.



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.

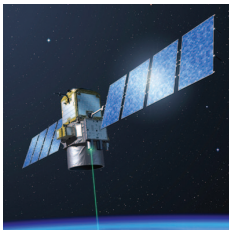
Aura

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



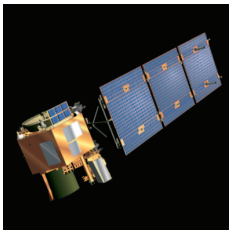
Launch Date: April 28, 2006
Phase: Extended
Partner: France
Web site: http://www-calipso.larc.nasa.gov

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

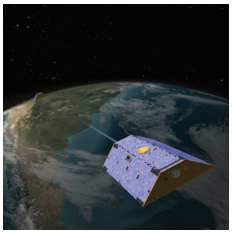
CloudSat provides a comprehensive characterization of the structure and composition of clouds and their effects on climate under all weather conditions using an advanced cloud profiling radar.



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

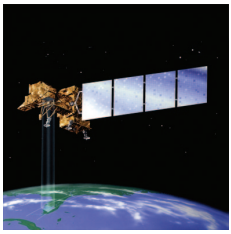
The GRACE mission accurately maps variations in the Earth's gravity field. GRACE data is used to estimate global models for the variable Earth gravity field approximately every 30 days, and reveals changes in levels of large underground aquifers.

Jason-1

Launch Date: December 07, 2001
Phase: Extended
Partner: France
Web site: http://sealevel.jpl.nasa.gov/mission/jason-1.html

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
Web site: http://sealevel.jpl.nasa.gov/mission/ostm.html

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
Web site: http://winds.jpl.nasa.gov/missions/quikscat

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.

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.

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

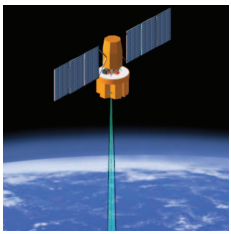
Launch Date: November 27, 1997
Phase: Extended
Partner: Japan
Web site: http://trmm.gsfc.nasa.gov

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 CO_2 Emissions over Nights, Days and Seasons

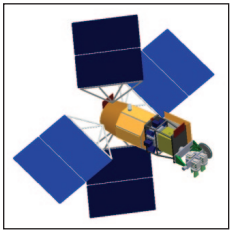


Launch Date: NET 2020
Phase: Pre-formulation

ASCENDS will measure the total column abundance of carbon dioxide (CO_2) 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.

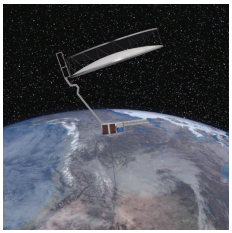
CLARREO

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.

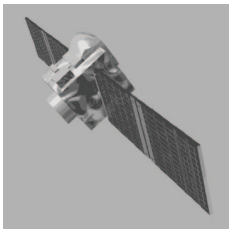


DESDynI

Deformation Ecosystem Structure & Dynamics of Ice

Launch Date: NET 2021
Phase: Pre-formulation
Web site: http://desdyni.jpl.nasa.gov

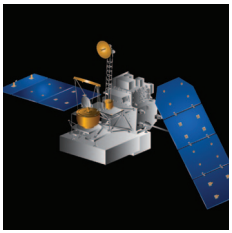
DESDynI will monitor surface deformation to improve understanding of earthquakes, volcanoes, and landslides. DESDynI data will be useful for managing our ground water resources, and for understanding the response of ice sheets, glaciers, and sea ice to climate change.



Earth Venture 2

Launch Date: 2017
Phase: Pre-formulation
Web site: http://science.nasa.gov/about-us/smd-programs/earth-system-science-pathfinder

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.



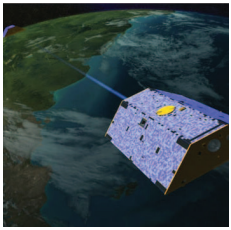
GPM

Global Precipitation Measurement

Launch Date: June 2014
Phase: Development
Partner: Japan
Web site: http://gpm.gsfc.nasa.gov

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

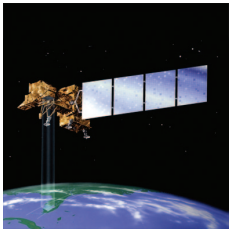
This mission will provide continuity of measurements of Earth's gravity field as a follow-on to the original GRACE mission, launched in March 2002, until the more capable Tier 3 NRC Decadal Survey GRACE-II mission can be developed.

ICESat II
Ice, Cloud, and land Elevation Satellite II

Launch Date: 2016
Phase: Formulation
Web site: http://icesat.gsfc.nasa.gov/index.php

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



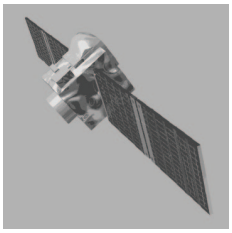
Launch Date: June 2013
Phase: Development
Partner: USGS
Web site: http://ldcm.nasa.gov

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

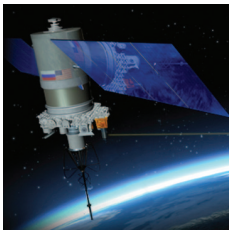
OCO-2 will provide the first complete picture of human and natural carbon dioxide sources and sinks by mapping their global geographic distribution studying their changes over time. The OCO-2 spacecraft will replace OCO-1, lost during a launch vehicle failure in 2009.



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.

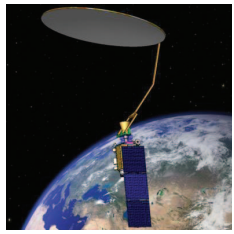


SAGE-III
Stratospheric Aerosol and Gas Experiment-III

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.

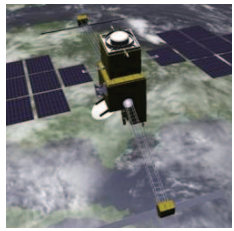
SMAP
Soil Moisture Active-Passive



Launch Date: 2015
Phase: Formulation
Web site: http://smap.jpl.nasa.gov

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
Web site: http://smap.jpl.nasa.gov

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.

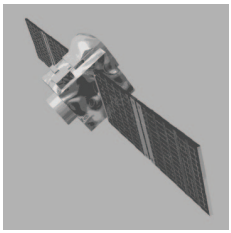
JASD

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.



DSCOVR
Deep Space Climate Observatory

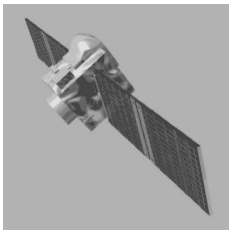
Launch Date: 2014
Phase: Development
Partner: Reimbursable NOAA partnership with US Air Force providing the launch vehicle

Provide early warning capability to detect space weather and solar events from the sun-earth L1 Lagrange point.

GOES-R
Geostationary Operational Environmental Satellite-R

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

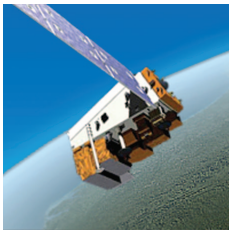
Provide geosynchronous environmental monitoring with greater resolution and coverage, the first geo-orbiting lightning mapper and increased capability to detect space weather and solar events.

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.

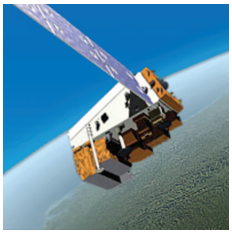
JPSS-1
Joint Polar Satellite System 1



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

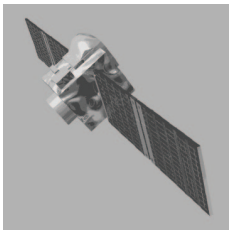
Provide data continuity for global environmental data used in numerical weather prediction models, climate modeling, and space weather observations.

JPSS-2
Joint Polar Satellite System 2



Launch Date: 2022
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.

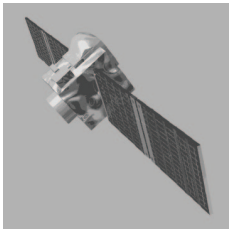


JPSS FF-1

JPSS Freeflyer-1

Launch Date: 2016
Phase: Pre-Formulation
Partner: Reimbursable NOAA partnership with GFE from CNES (France) and DND (Canada).

Provide on-going measurements of the sun's absolute irradiance for climate modeling studies, and to also provide critical lifesaving and research capabilities.



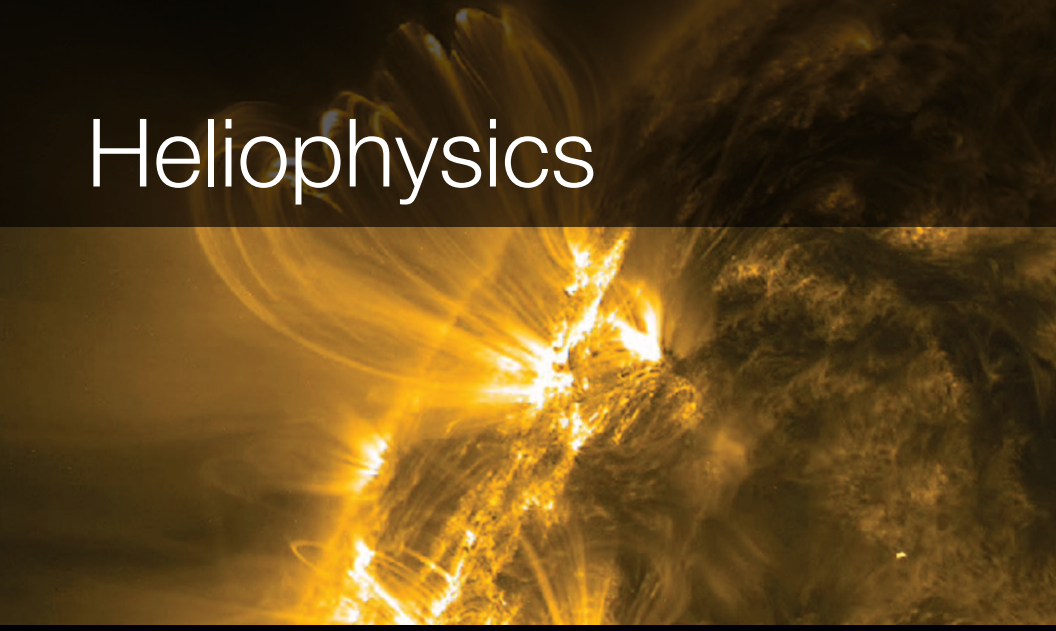
TCTE

TSI Calibration Transfer Experiment

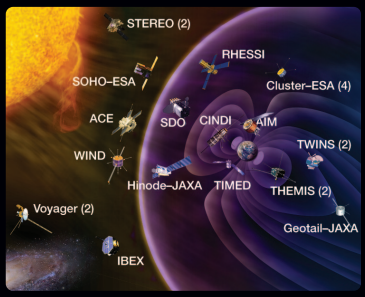
Launch Date: 2013
Phase: Development
Partner: Reimbursable NOAA partnership with US Air Force providing the spacecraft bus and launch vehicle.

Provide a Total Solar Irradiance (TSI) measurement that will span the period from the SORCE mission (currently flying) to the JPSS Freeflyer-1 mission (planned for 2016) in order to mitigate the potential of a break in the 34 year long solar irradiance data record critical for modeling the climate of the earth.

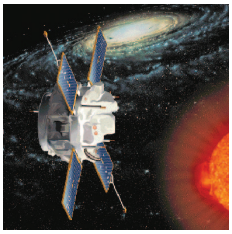
Heliophysics



Understand the Sun and its interactions with the Earth and the solar system.



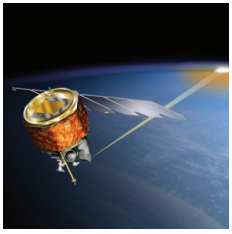
Our planet is immersed in a seemingly invisible yet exotic and inherently hostile environment. Above the protective cocoon of Earth's atmosphere is a plasma soup composed of electrified and magnetized matter entwined with penetrating radiation and energetic particles. Our Sun's energy output, which varies 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 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
Web site: http://www.srl.caltech.edu/ACE

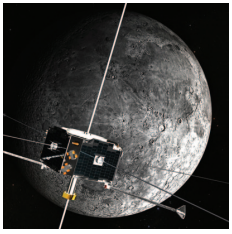
ACE observes particles of solar, interplanetary, interstellar and galactic origins. ACE's solar wind observations are used on an operational basis for space weather forecasting by both NOAA and USAF.



AIM
Aeronomy of Ice in the Mesosphere

Launch Date: April 25, 2007
Phase: Extended
Web site: http://www.nasa.gov/mission_pages/aim/index.html

AIM explores Polar Mesospheric Clouds (also called noctilucent clouds), which form an icy membrane at the edge of Earth's atmosphere, to find out why they form and why they are changing.

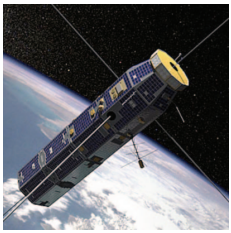


ARTEMIS
Acceleration, Reconnection, Turbulence and Electrodynamics of the Moon's Interaction with the Sun

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.

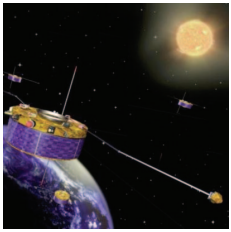
CINDI/CNOFS
Coupled Ion-Neutral Dynamics Investigation



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

The CINDI/CNOFS instrument suite uncovers the role of ion-neutral interactions in the generation of small and large-scale electric fields in the Earth's upper atmosphere.

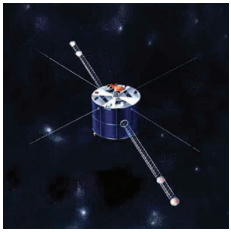
Cluster-II



Launch Date: July 16, 2000
Phase: Extended
Partner: European Space Agency
Web site: http://www-istp.gsfc.nasa.gov/istp/misc/cluster.html

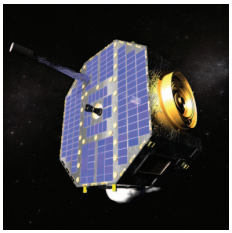
Cluster II conducts an in-situ investigation of the Earth's magnetosphere using four identical spacecraft simultaneously, allowing the determination of three-dimensional and time-varying phenomena and the differences between spatial and temporal variations.

Geotail



Launch Date: July 24, 1992
Phase: Extended
Partner: Japan
Web site: http://www-istp.gsfc.nasa.gov/istp/geotail/geotail.html

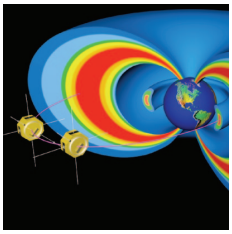
Geotail studies the dynamics of the Earth's magnetotail over a wide range of distances and measures global energy flow and transformation in the magnetotail.



IBEX
Interstellar Boundary Explorer

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

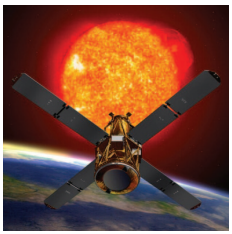
IBEX measures energetic neutral atoms created at the boundary that separates our heliosphere from the local interstellar medium.



RBSP
Radiation Belt Storm Probes

Launch Date: August 2012
Phase: Development
Partner: Czech Republic
Web site: http://rbsp.jhuapl.edu

RBSB 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. It is anticipated that RPSP observations will be used on an operational basis for space weather forecasting by both NOAA.



RHESSI
Reuven Ramaty High Energy Solar Spectroscope Imager

Launch Date: February 5, 2002
Phase: Extended
Web site: http://hesperia.gsfc.nasa.gov/rhessi2

RHESSI advances 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
Partner: European Space Agency
Web site: http://sohowww.nascom.nasa.gov

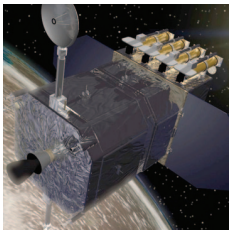
SOHO studies the internal structure of the Sun, its extensive outer atmosphere and the origin of the solar wind in tandem with ESA's two related solar observatories. SOHO observations are used on an operational basis for space weather forecasting by NOAA.

Solar-B/Hinode

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

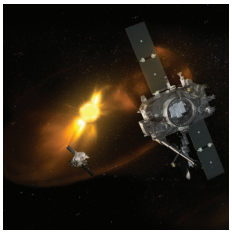
Japan's Hinode mission uses a three-instrument suite to understand how energy generated by magnetic-field changes in the photosphere is transmitted to the corona, how that energy influences the dynamics and structure of the corona, and how the energy transfer and atmospheric dynamics affects the interplanetary-space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

SDO
Solar Dynamics Observatory



Launch Date: February 11, 2010
Phase: Prime
Partner: Russia
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 solar irradiance.

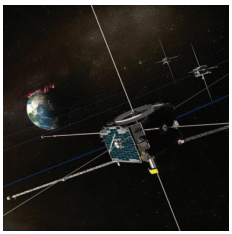


STEREO

Solar Terrestrial Relations Observatory

Launch Date: October 25, 2006
Phase: Extended
Partners: France, Switzerland, United Kingdom, Germany, Belgium, DoD
Web site: http://stereo.gsfc.nasa.gov

STEREO traces the flow of energy and matter from the Sun to Earth with two space-based observatories, as well as reveals the 3D structure of coronal mass ejections and the reasons why they happen. STEREO observations are used on an operational basis for space weather forecasting by NOAA.

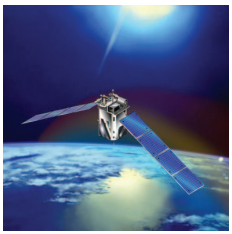


THEMIS

Time History of Events and Macroscale Interactions during Substorms

Launch Date: February 17, 2007
Phase: Extended
Partners: Canada, Germany, France and Austria
Web site: http://www.nasa.gov/mission_pages/themis/main/index.html

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

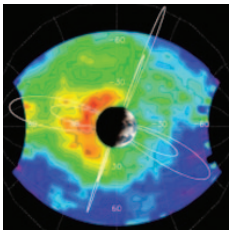
Thermosphere, Ionosphere, Mesosphere Energetics and Dynamics

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

TIMED explores the Earth's Mesosphere and Lower Thermosphere (60–180 kilometers up) to 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

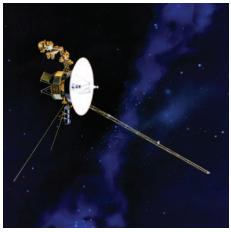
Two Wide-Angle Imaging Neutral-Atom Spectrometers



Launch Date: A-June 2006, B-March 13, 2008
Phase: Extended
Partner: NRO, Germany
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.

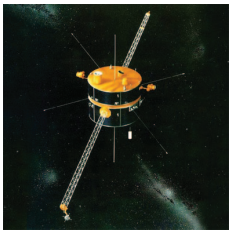
Voyager



Launch Date: August and September 1977
Phase: Extended
Web site: http://voyager.jpl.nasa.gov/mission/mission.html

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.

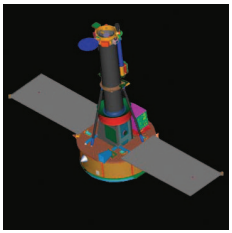
Wind



Launch Date: November 1, 1994
Phase: Extended
Web site: http://wind.nasa.gov

Wind measures crucial properties of the solar wind before it impacts the Earth's magnetic field and alters the Earth's space environment.

FUTURE MISSIONS

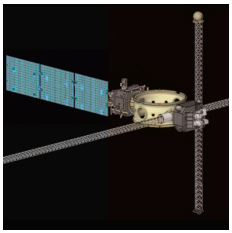


IRIS

Interface Region Imaging Spectrograph

Launch Date: June 2013
Phase: Development
Partner: NRO, Norway
Web site: http://iris.lmsal.com/#ov

IRIS will 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 spectroscopy and imaging.

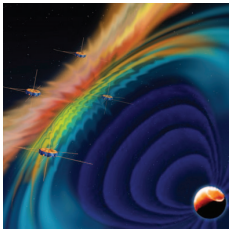


LWS SET-1

Living With a Star Space Environment Testbed-1

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

LWS-SET-1 will improve the engineering approach to accommodate and / or mitigate the effects of solar variability on spacecraft design and operations, specifically demonstrate improved hardware performance in the space radiation environment.



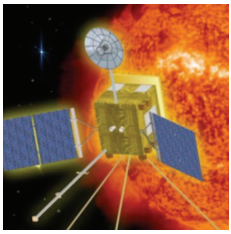
MMS

Magnetospheric MultiScale Mission

Launch Date: August 2014
Phase: Development
Partners: Austria, France, Japan and Sweden
Web site: http://mms.gsfc.nasa.gov

MMS will consist of 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.

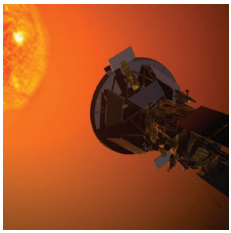
Solar Orbiter Collaboration



Launch Date: 2017
Phase: Formulation
Partner: European Space Agency-led
Web site: http://sci.esa.int/solarorbiter

The Solar Orbiter mission will study the Sun from a distance closer than any spacecraft previously has. This mission will explore the inner solar system to improve the understanding of how the Sun determines the environment of the inner solar system and how fundamental plasma physical processes operate near the Sun. To answer these questions, it is essential to make in-situ measurements of the solar wind plasma, fields, waves, and energetic particles close enough to the Sun that they are still relatively unprocessed, and to connect the in situ measurements with remote sensing of the near-Sun atmosphere.

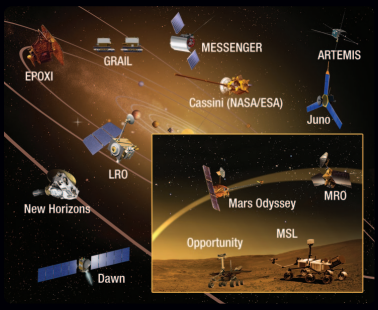
Solar Probe Plus



Launch Date: 2018
Phase: Formulation
Partners: France, Germany
Web site: http://solarprobe.gsfc.nasa.gov

The First Mission to the Nearest Star, Solar Probe Plus will be a historic mission, flying into the Sun's atmosphere (or corona), for the first time. Coming closer to the Sun than any previous spacecraft, Solar Probe Plus will employ a combination of in situ measurements and imaging to achieve the mission's primary scientific goal: to understand how the Sun's corona is heated and how the solar wind is accelerated. Solar Probe Plus will revolutionize our knowledge of the physics of the origin and evolution of the solar wind.

Planetary Science



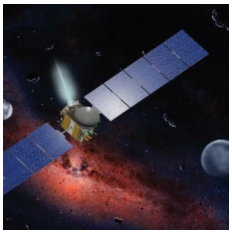
Ascertain the content, origin, and evolution of the solar system, and the potential for life elsewhere.

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.

Cassini

Launch Date: October 15, 1997
Phase: Extended
Partners: European Space Agency and Italy
Web site: http://saturn.jpl.nasa.gov

Cassini arrived at Saturn in 2004 and completed its first extended mission in Sept. 2010, and it is seeking to making 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
Arrival: Vesta–2011, Ceres–2015
Web site: http://dawn.jpl.nasa.gov

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 asteroids remaining intact since their formations. Ceres and Vesta reside in the main asteroid belt between Mars and Jupiter.

Deep Impact/EPOXI

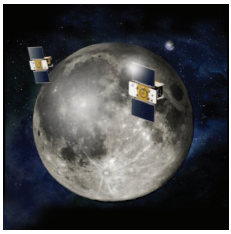
Extrasolar Planet Observation and Deep Impact Extended Investigation

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

EPOXI is the supplemental mission that used NASA's Deep Impact spacecraft to perform a flyby of comet Hartley 2. And make observations of extra-solar planetary systems.. EPOXI made its closest approach to Hartley 2 on November 4, 2010.

GRAIL (Ebb and Flow)

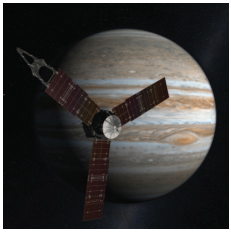
Gravity Recovery And Interior Laboratory



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

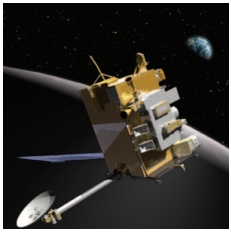


Launch Date: August 5, 2011
Phase: Prime
Arrival: at Jupiter in 2016
Partners: Belgium and Italy
Web site: www.nasa.gov/juno

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: Extended
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. LRO's extended science mission will study polar volatiles, early planetary processes, impact history, and the Moons interaction with solar wind.

Mars Express

Launch Date: April, 2, 2003
Phase: Extended
Partners: This is an ESA led mission with U.S. Participation
Web site: http://mars.jpl.nasa.gov/odyssey

The Mars Express orbiter is contributing to Mars science by mapping the martian mineralogy and subsurface structure as well as gathering information on the atmospheric composition to determine global circulation patterns. The U.S. led MARSIS instrument team jointly with the MRO SHARAD team recently discovered evidence of a subsurface ocean on Mars.

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

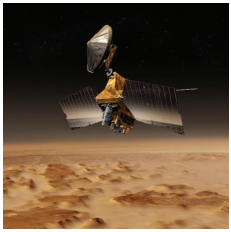
MESSENGER is imaging all of Mercury for the first time, as well as gather data on the composition and structure of Mercury's crust, its geologic history, the nature of its active magnetosphere and thin atmosphere, and the makeup of its core and the materials near its poles. By studying Mercury, NASA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

MSL (Curiosity)
Mars Science Laboratory

Launch Date: November 26, 2011
Phase: Prime
Partners: Canada, France, Germany, Spain and Russia
Web site: http://mars.jpl.nasa.gov/msl

MSL's Curiosity rover is assessing 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, it to arrived on the Martian surface on August 6 2012.

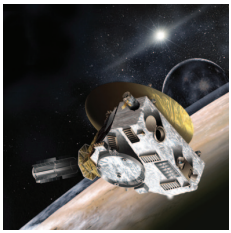
MRO
Mars Reconnaissance Orbiter



Launch Date: August 12, 2005
Phase: Extended
Partner: Italy
Web site: http://mars.jpl.nasa.gov/mro

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 provided 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.

New Horizons



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

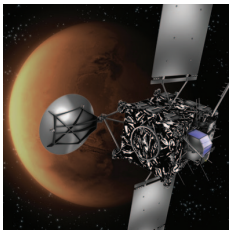
New Horizons is designed to help us understand worlds at the edge of our solar system by making the first reconnaissance of Pluto and Charon, and one or more Kuiper Belt objectives beyond, to reveal the origin and evolution of our planetary neighbors. New Horizons is a New Frontiers mission.

MER (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 eighth year of a 90-day mission, Opportunity is poised to explore the giant crater Endeavor.



Rosetta

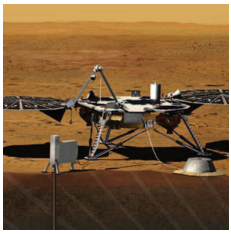
Launch Date: March 2, 2004
Phase: Prime
Arrival at Comet: May 2014
Partner: ESA Led mission with U.S. Participation
Web site: http://rosetta.jpl.nasa.gov

The Rosetta mission is an orbiter and lander with the goal of investigating the origin of comets. The orbiter will rendezvous with Comet 67P/ Churyumov-Gerasimenko and remain in close proximity to the icy nucleus as it plunges toward the Sun. At the same time, a small lander will be released onto the surface of the comet for in-situ investigations of the chemistry and formation of volatiles. Rosetta will be the first spacecraft to accompany a comet around the Sun.

FUTURE MISSIONS

InSight

Interior Exploration using Seismic Investigations, Geodesy and Heat Transport

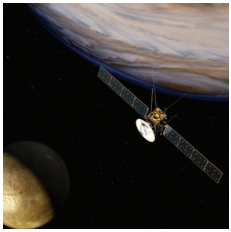


Launch Date: September 2016
Phase: Development
Web site: http://insight.jpl.nasa.gov

The Interior Exploration using Seismic Investigations, Geodesy and Heat Transport mission is a Mars lander dedicated to studies of the planets interior. The mission will place instruments on the martain surface to investigate whether the core of Mars is solid or liquid like Earth's, and why Mars' crust is not divided into tectonic plates that drift like Earth's. Detailed knowledge of the interior of Mars in comparision to Earth will help scientists understand how terrestrial planets form and evolve. InSight is a Discovery Program mission.

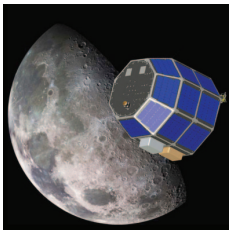
JUICE

Jupiter Ice Moon Orbiter



Launch Date: November 2021
Phase: Development
Arrival: May 2028
Partner: ESA Led mission with U.S. Participation
Web site: http://soma.larc.nasa.gov

The JUICE spacecraft is a solar-powered orbiter that will spend seven-and-a-half years cruising to Jupiter after its launch. Once at it's destination, the probe will study Jupiter's atmosphere and magnetosphere, and investigate how the Galilean moons (Callisto Europa, Ganymede, and Io) interact with the gas giant. In 2032, the JUICE probe will enter orbit around Ganymede, Jupiter's largest moon and the only moon in the Solar system known to harbor its own magnetic field. The JUICE mission aims to study the magnetic field as well as map the moons icy surface and interior structure.



LADEE

Lunar Atmosphere and Dust Environment Explorer

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

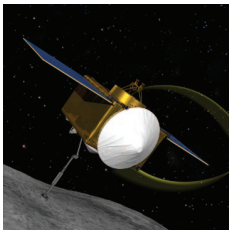
LADEE will orbit the Moon and its main objective is to characterize the atmosphere and lunar dust environment. LADEE aims to determine the global density, composition, and time variability of the fragile lunar atmosphere before it is perturbed by further surface exploration activity.

MAVEN

Mars Atmosphere and Volatile Evolution

Launch Date: November 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 role that the loss of volatile compounds—such as carbon dioxide, nitrogen dioxide, and water—from the Mars atmosphere to space has played through time.



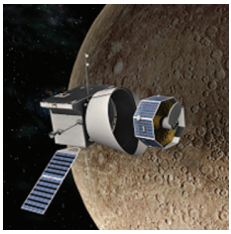
OSIRIS-Rex

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 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.

Strofio/Bepi Colombo



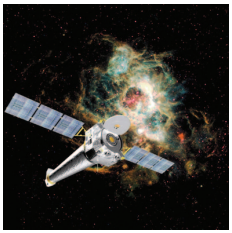
Launch Date: 2014
Phase: Development
Partner: ESA
Web site: http://discovery.nasa.gov/strofio.cfml

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 how planets and planetary systems form 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

Chandra X-ray Observatory

Launch Date: July 23, 1999
Phase: Extended
Partner: Germany, the Netherlands
Web site: http://chandra.harvard.edu/about

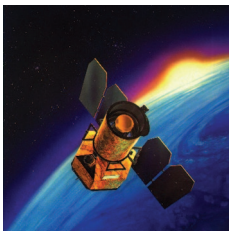
Chandra is a NASA Great Observatory whose high-resolution telescope is specially designed to detect and image X-ray emissions from very hot and highly energetic regions of the universe such as exploded stars, clusters of galaxies, and matter around black holes.

Fermi

Fermi Gamma-ray Space Telescope

Launch Date: June 11, 2008
Phase: Prime
Partners: DOE, Germany, Japan, France, Italy and Sweden
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.



GALEX

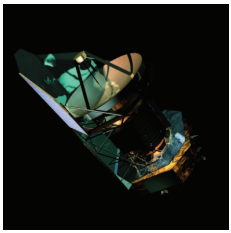
Galaxy Evolution Explorer

Launch Date: April 28, 2003
Phase: Operating post-extended mission, on loan to Caltech
Partners: France, South Korea
Web site: http://www.galex.caltech.edu

GALEX observes galaxies in ultraviolet light. Since its launch it has surveyed tens of thousands of galaxies across ten billion years of time. GALEX has mapped the history of star formation and evolution in the universe by performing several ultraviolet all-sky imaging surveys and ultraviolet wide-area spectroscopic observations. In May 2012 GALEX operations were transferred to the California Institute of Technology under a Space Act Agreement. GALEX will be returned to NASA for decommissioning.

Herschel

Herschel Space Observatory



Launch Date: May 14, 2009
Phase: Prime
Partners: ESA, United Kingdom, Netherlands
Web site: http://herschel.jpl.nasa.gov

ESA's Herschel is a space-based telescope that studies the universe in the submillimeter and far-infrared. NASA provided key technologies to two of Herschel's three detector instruments. Herschel is revealing new information about the earliest, most distant stars and galaxies, as well as those closer to home in space and time. It also looks at star and planetary formation, and the chemistry of the universe.

Hubble

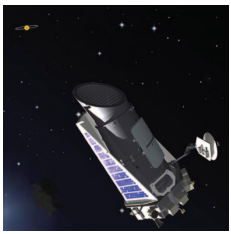
Hubble Space Telescope

Launch Date: April 24, 1990
Phase: Prime
Partner: ESA
Web site: http://hubble.nasa.gov

Hubble, a NASA Great Observatory, has provided astronomers a clear and deep view of the cosmos in the visible, ultraviolet, and near-infrared. Hubble has been used to measure the expansion rate of the universe and the evolution of objects within it. Hubble has also detected atomic constituents in the atmospheres of planets outside our solar system. Hubble has provided iconic images of galaxies, nebulae, star-forming regions and planets.

Kepler

Fermi Gamma-ray Space Telescope



Launch Date: March 06, 2009
Phase: Extended
Web site: http://kepler.nasa.gov

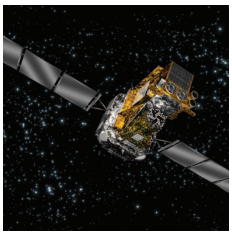
Kepler is designed to survey a portion of our region of the Milky Way galaxy to discover dozens of Earth-size planets in or near the habitable zone and determine how many of the billions of stars in our galaxy have such planets. Also discovers thousands of other kinds of planets and establishes how common planets are around other stars.

NuSTAR

Nuclear Spectroscopic Telescope Array

Launch Date: June 13, 2012
Phase: Prime
Partners: Denmark, Italy
Web site: http://www.nustar.caltech.edu

NuSTAR represents the first astronomical observatory having the capability to image the high-energy X-ray sky. NuSTAR's capabilities enable scientists to investigate important astrophysical systems, including supermassive black holes enshrouded in gas and dust, the origin of elements in supernova explosions, and the physics of collapsed stars with intense magnetic fields.



Planck

Planck Space Observatory

Launch Date: May 14, 2009
Phase: Extended
Partners: ESA, Italy, France, United Kingdom
Web site: http://sci.esa.int/planck

ESA's Planck mission uses microwave detectors to study fundamental questions in cosmology. A NASA-provided cooler system enables Planck to reach its operating temperature of 17° Kelvin. 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. Planck detects the remnant radiation from the Big Bang.

SOFIA

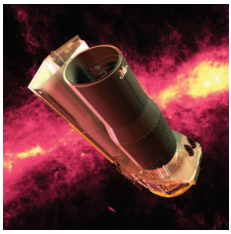
Stratospheric Observatory for Infrared Astronomy

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

SOFIA is the largest airborne observatory in the world, housed in a modified Boeing 747SP. It is used to study the formation of stars and planetary systems, in addition to many other phenomena. SOFIA is in the latter stages of development, with the first full-scale science campaign starting at the end of 2012 and full operational capability to be achieved by 2014. Early science flights have already produced some exciting results.

Spitzer

Spitzer Space Telescope

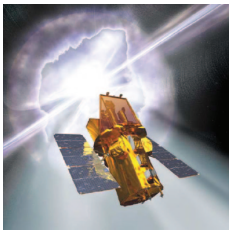


Launch Date: August 25, 2003
Phase: Extended
Web site: http://science.nasa.gov/missions/spitzer

Spitzer is a NASA Great Observatory that operates in the infrared. Although some of its capabilities ended with the natural depletion of its cryogen in 2009, Spitzer has continued to take unprecedented near-infrared images. Spitzer peers through the dust in the galaxy to study the formation of stars and planets and to characterize the properties of exoplanets.

Swift

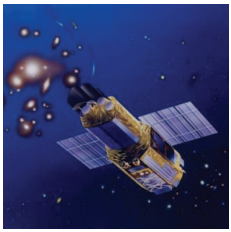
Swift Gamma-ray Burst mission



Launch Date: November 20, 2004
Phase: Extended
Partners: Italy, United Kingdom
Web site: http://www.nasa.gov/swift

Swift's three instruments work together to observe gamma-ray bursts and their afterglows in the gamma ray, X-ray, ultraviolet, and optical wavebands. Within seconds of detecting a burst, Swift relays its location to ground stations, allowing ground-based and space-based telescopes the opportunity to observe the burst's afterglow.

Suzaku



Launch Date: July 10, 2005
Phase: Extended
Partner: Japan
Web site: http://www.nasa.gov/astro-e2

Japan's Suzaku studies the universe in the X-ray energy range. Carrying instruments covering a wide energy band, has allowed detailed studies of a wide range of high energy sources and processes. Suzaku studies the structure and evolution of the universe, structure and evolution of clusters of galaxies, and searches for highly obscured primordial objects. NASA provided one of Suzaku's three instruments.

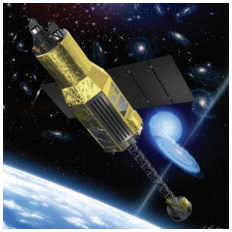
XMM-Newton

X-ray Multi-Mirror Newton Mission

Launch Date: December 10, 1999
Phase: Extended
Partner: ESA
Web site: http://heasarc.gsfc.nasa.gov/docs/xmm/xmmhp_aboutxmm.html

ESA's XMM-Newton is an X-ray observatory that detects and studies a wide variety of celestial X-ray sources. It has helped scientists to investigate a number of cosmic mysteries, ranging from the nature of black holes to the physics of the largest structures in the universe. NASA provided elements of XMM-Newton's instrument package.

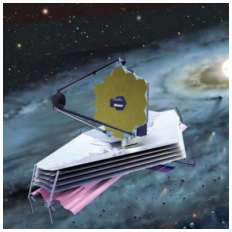
FUTURE MISSIONS



Astro-H

Launch Date: August 2014
Phase: Development
Partner: Japan
Web site: http://heasarc.nasa.gov/docs/astroh

Japan's Astro-H mission is an X-ray observatory. Its primary scientific goals include: (a) tracing the growth history of the largest structures in the universe; (b) providing insights into the behavior of material in extreme gravitational fields; (c) determination of the spin of black holes; and (d) investigation of the detailed physics of astrophysical jets. NASA is collaborating with JAXA on the Soft X-ray Spectrometer (SXS) instrument and mirrors.



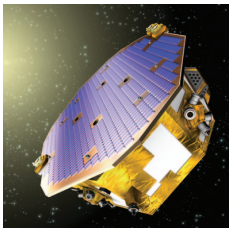
JWST

James Webb Space Telescope

Launch Date: 2018
Phase: Development
Partners: ESA and Canada
Web site: http://www.jwst.nasa.gov

James Webb Space Telescope is NASA's largest space telescope ever and it is optimized for the infrared wavelength. 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.

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. The Disturbance Reduction System is one of the key technologies that will enable a future space-based gravity wave observatory similar in design to the Large Interferometer Space Antenna (LISA). ST-7 is an essential step in the process to determine whether NASA and ESA will proceed with the Large Interferometer Space Antenna (LISA).

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