OUTCOME 2.2: UNDERSTAND THE SUN AND ITS INTERACTIONS WITH THE EARTH AND THE SOLAR SYSTEM.

Billions of years ago, at the core of the Sun, a nuclear furnace ignited. The energy the Sun provides, radiated almost constantly from its visible surface, is the basis of all advanced life on Earth. The Sun is a variable star, and its waxing and waning magnetic activity is the driver of space weather at Earth and across the solar system. Earth and the other planets reside in the extended atmosphere of the Sun. This extended atmosphere, called the heliosphere, comprises a plasma "soup" of electrified and magnetized matter entwined with penetrating radiation and energetic particles.

NASA's Heliophysics Division conducts missions that study the Sun, heliosphere, and planetary atmospheres as a single interconnected system. By analyzing these interconnections, scientists uncover fundamental physical processes that occur throughout the universe. These missions also improve capabilities for predicting the impacts of solar variability on human technological systems and safeguarding human and robotic space explorers outside the protective cocoon of Earth's atmosphere.

NASA's research in heliophysics has improved the understanding of space weather. NASA partners with National Oceanic and Atmospheric Administration (NOAA) to serve the Nation's need for reliable space weather information. NASA spacecraft, equipped with space weather beacons, provide real-time data to NOAA space weather forecasters. NASA cooperates with other agencies to enable new knowledge in this area and to measure conditions in space critical to both operations and scientific research.

Providing National Scientific Capabilities for Heliophysics

NASA continues to develop the Nation's capabilities in support of these science objectives by funding research and mission development performed by scientists and engineers at universities, research centers, private sector organizations, and NASA Centers. The vast majority of research awards also include funding for postdoctoral fellows, graduate students, and undergraduate students, thereby supporting the education and training of future scientists and engineers.

Programs and activities serving this goal in FY 2012 include:

- Basic technology development in detector systems, plasma physics and materials sciences;
- Suborbital rocket RockSat program;
- Postdoctoral and early career Earth and Space Science Fellowships, Jack Eddy Heliophysics Postdoctoral Fellowship Program, and the Heliophysics Summer School;
- Presidential Early Career Award for Scientists and Engineers;
- Hands-on Project Experience; and
- Heliophysics textbook development.

The establishment, operation, and maintenance of necessary facilities is critical to the Nation's scientific capabilities. In FY 2012, NASA provided:

- Mission operations, basic data analysis, and resources for the operation centers for the

Voyager, IBEX, Geotail, Cluster, RHESSI, TIMED, AIM, STEREO, THEMIS, ARTEMIS, Hinode, SDO, TWINS, CINDI, Wind, ACE, SOHO, and Van Allen Probes missions;

- Data archives that capture all NASA heliophysics data and provide open access to the science community and the public: the Solar Data Analysis Center, Joint Science Operations Center, Virtual Observatories, Heliophysics Data Environment Enhancements, and the Space Physics Data Facility, the integrated Space Weather Analysis system (iSWA) that captures and makes publically available NASA/Heliophysics real-time data;
- Operation of the Nation's scientific suborbital sounding rocket facilities; and
- Support for the Community Coordinated Modeling Center for the testing, verification, and validation of the latest heliophysics models.

NASA requires that all funded research investigations publish their results in open, peer reviewed science literature, ensuring that data and knowledge are captured. Each year, the Heliophysics Subcommittee of NASA's external advisory Science Committee evaluates the progress made by NASA toward each science objective. In FY 2012, the subcommittee found that expectations had been fully met by research results that included those discussed below.

Reported Multi-Year Performance

Multi-Year Performance Goal 2.2.1.1: Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base. (In support of objective 2.2.1: "Improve understanding of the fundamental physical processes of the space environment from the Sun to Earth, to other planets, and beyond to the interstellar medium.")

FY11
Green
FY12
Green

During FY 2012, NASA supported the development of the Nation's scientific capabilities in this heliophysics science area through many efforts, including early career fellowships, low cost access to space suborbital rockets, and the data and modeling centers.

Voyager and IBEX Probe the Heliosphere's Interaction with the Local Interstellar Medium

As the Sun moves through the local interstellar medium, the solar wind carves out a cavity known as the heliosphere that protects Earth from harmful galactic cosmic radiation. The Interstellar Boundary Explorer (IBEX) measures energetic neutral atoms created by the interaction between interstellar neutral gas and energetic protons near the edge of the solar system, as well as the interstellar neutral gas that flows directly into the inner solar system. Simultaneously, the Voyager spacecraft provide direct measurements of particles, plasmas, and magnetic fields in the heliosheath, the boundary region between the heliosphere and the interstellar medium. IBEX has measured the speed of the Sun through the local interstellar medium much more precisely than before. The Sun moves at 52,000 miles per hour, roughly 7,000 miles per hour slower and in a somewhat different direction than previously thought. These observations also show that oxygen is roughly half as abundant in the local interstellar medium as in the solar system, which suggests that either large amounts of oxygen atoms are embedded in interstellar dust grains or Earth's solar system was born outside the local interstellar cloud. At this speed, the Sun and heliosphere create a bow wave rather than a bow shock in the interstellar medium.

In the meantime, the Voyager 1 spacecraft entered a new, unexplored region between the solar system and interstellar space in which the solar wind has slowed down to be

	essentially stagnant, the solar system's magnetic field is piled up, and higher-energy particles from inside the solar system appear to be leaking out into interstellar space. This lends further credence to the notion that the Sun's distant magnetic field may consist of bubbles approximately 100 million miles wide that are somehow disconnected from the Sun's magnetic field. These new observations have forced a re-examination of scientists' understanding of the location and nature of the heliosphere's interaction with the galactic environment, which will lead to better understanding of how galactic cosmic rays enter and penetrate deep into the solar system. (Read more about this story.) **Long-Term Changes and Trends in Earth's Atmosphere and Ionosphere** NASA researchers, in cooperation with the international scientific community, reviewed long-duration records of the upper atmosphere. They used data from the NASA Thermosphere, Ionosphere, Mesosphere, Energetics and Dynamics (TIMED) satellite, along with ground-based Global Positioning Satellite (GPS) receivers, radars, and lidars, to identify long-term trends in the temperature, composition and density of Earth's upper atmosphere between about 50 and 500 kilometers above the ground. More than 20 years ago, researchers predicted that global cooling would occur in the upper atmosphere. This cooling trend and an associated contraction of Earth's upper atmosphere were finally confirmed with this set of correlative observations. The increasing concentration of greenhouse gases, along with other processes such as stratospheric ozone depletion, Earth's slowly changing magnetic field, and drifting weather patterns, all exhibit long-term changes in addition to those due to solar activity. Researchers are now quantifying and understanding changes occurring at all altitudes within Earth's coupled atmospheric system, including those regions extending into the near space environment. (Read more on this story.)

Update to Multi-Year Performance Goal	
FY13 Update	This performance goal remains the same in FY13.
FY14	This performance goal remains the same in FY14.

Reported Annual Performance					
HE-12-1: Demonstrate planned progress in understanding the fundamental physical processes of the space environment from the Sun to Earth, to other planets, and beyond to the interstellar medium. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.					
Contributing Theme:		Heliophysics			
Contributing Program(s):		Multiple Programs			
FY07	**FY08**	**FY09**	**FY10**	**FY11**	**FY12**
7ESS13 Green	**8HE01 Green**	**9HE1 Green**	**10HE01 Green**	**HE-11-1 Green**	**HE-12-1 Green**

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Planned Annual Performance	
FY13 Update	HE-13-1: Demonstrate planned progress in understanding the fundamental physical processes of the space environment from the Sun to Earth, to other planets, and beyond to the interstellar medium. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.
FY14	HE-14-1: Demonstrate planned progress in understanding the fundamental physical processes of the space environment from the Sun to Earth, to other planets, and beyond to the interstellar medium. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.

Reported Annual Performance					
No annual performance goal in FY12.					
Contributing Theme:		Heliophysics			
Contributing Program(s):		Living with a Star			
FY07	**FY08**	**FY09**	**FY10**	**FY11**	**FY12**
7ESS14 Yellow	**8HE06 Green**	**None**	**None**	**None**	**None**
Planned Annual Performance					
FY13 Update	HE-13-2: Achieve mission success criteria for the Solar Dynamics Observatory (SDO).				
FY14	No annual performance goal in FY14.				

Reported Annual Performance	
No annual performance goal in FY12 or trended performance.	
Contributing Theme:	Heliophysics
Contributing Program(s):	Living with a Star
Planned Annual Performance	
FY13 Update	No annual performance goal in FY13.
FY14	HE-14-2: Achieve mission success criteria for Van Allen Probes Mission.

Reported Multi-Year Performance

Multi-Year Performance Goal 2.2.1.2: By 2015, launch two missions in support of objective 2.2.1.

FY11
Green
FY12
Green

The purpose of this performance goal is to design, develop, and launch satellites in support of objective 2.2.1, as outlined in the NASA Science Mission Directorate's 2010 Science Plan. The launch of these missions will provide not only critical new knowledge, but will also broaden the distribution and capabilities of observation posts that are needed to study the full range of Sun-solar system connections. This combination of new heliophysics knowledge and a well-supported constellation of operating missions can facilitate the path towards an operational capability to predict space weather.

NASA launched the first mission in support of this performance goal, the two-spacecraft Radiation Belt Storm Probes (RBSP), on August 30, 2012. Following on-orbit checkout, the mission was renamed the Van Allen Probes. The mission will observe the fundamental processes that energize and transport radiation belt electrons and ions in Earth's inner magnetosphere, the area in and around Earth's radiation belts. These observations will

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	provide new knowledge on the dynamics and extremes of the radiation belts that are important to all technological systems that fly in and through geospace. NASA plans to launch the second mission, Magnetospheric Multiscale (MMS) by 2015. The MMS mission will use Earth's magnetosphere as a laboratory to study the microphysics of magnetic reconnection, a fundamental plasma-physical process that converts magnetic energy into heat and the kinetic energy of charged particles. On August 30, NASA completed the MMS System Integration Review, giving the project the go-ahead to integrate the systems into the spacecraft bus for testing and keeping this performance goal on track for completion by 2015. A subsequent review gave MMS approval to proceed into assembly, integration, and testing.

Update to Multi-Year Performance Goal	
FY13 Update	This performance goal remains the same in FY13.
FY14	This performance goal remains the same in FY14.

Reported Annual Performance					
HE-12-2: Complete the Magnetospheric MultiScale (MMS) Systems Integration Review.					
Contributing Theme:		Heliophysics			
Contributing Program(s):		Solar Terrestrial Probes			
FY07	**FY08**	**FY09**	**FY10**	**FY11**	**FY12**
7ESS15 Red	**8HE02 Green**	**9HE2 Green**	**10HE02 Green**	**HE-11-2 Green**	**HE-12-2 Green**
Planned Annual Performance					
FY13 Update	HE-13-3: Complete integration of the payload to the Magnetospheric Multiscale (MMS) satellite #1 (of four).				
FY14	HE-14-3: Complete Magnetospheric MultiScale (MMS) Observatory #4 Environmental Test.				

Reported Annual Performance					
HE-12-3: Complete the Geospace Radiation Belt Storm Probes Launch Readiness Review.					
Contributing Theme:		Heliophysics			
Contributing Program(s):		Living with a Star			
FY07	**FY08**	**FY09**	**FY10**	**FY11**	**FY12**
7ESS16 Green	**8HE04 Green**	**9HE3 Green**	**10HE03 Green**	**HE-11-3 Green**	**HE-12-3 Green**
Planned Annual Performance					
FY13 Update	No annual performance goal in FY13.				
FY14	No annual performance goal in FY14.				
Comments	NASA successfully launched the Geospace Radiation Belt Storm Probes spacecraft, now called the Van Allen Probes, on August 30, 2012. The Van Allen Probes will contribute scientific data in support of performance goals 2.2.1.1 and 2.2.2.1 through FY 2014, when it will conclude its prime mission. At that time NASA will evaluate whether the Van Allen Probes achieved its mission success criteria.				

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Reported Multi-Year Performance

Multi-Year Performance Goal 2.2.2.1: Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base. (In support of objective 2.2.2: "Improve understanding of how human society, technological systems, and the habitability of planets are affected by solar variability interacting with planetary magnetic fields and atmospheres.")

FY11
Green
FY12
Green

During FY 2012, NASA supported the development of the Nation's scientific capabilities in this heliophysics science area through many efforts, including early career fellowships, Living With a Star Targeted Research and Technology Programs, and the Community Coordinated Modeling Center, a facility that is open for researchers to provide the latest Heliophysics models for testing, verification and validation.

Discovery of Energetic Late-Phase Emissions from Solar Flares and Their Impact on Earth's Upper Atmosphere

Solar flares are intense bursts of highly energetic radiation caused by the release of magnetic energy associated with sunspot regions. When the energy from eruptive flares, the largest explosive events in the solar system, impacts Earth's atmosphere, it alters the atmospheric structure, which in turn can affect the efficient operation of Earth-orbiting communication and navigation satellites. In particular, the energetic ultraviolet to X-ray emission from flares adds additional heat to Earth's upper atmosphere. Solar flares continue to surprise: observations by the Solar Dynamics Observatory (SDO) and the Reuven Ramaty High Energy Solar Spectroscopic Imager (RHESSI) revealed that a substantial fraction (about 15 percent) of flares have a pronounced "late phase" that can pump more than 40 percent of the total energy out into space than previously realized. The Thermosphere, Ionosphere, Mesosphere, Energetics and Dynamics (TIMED) mission measured the impact of a powerful solar flare in March 2012, also measured by SDO, on Earth's upper atmosphere. In direct response to the energy input from the flare, the upper atmosphere was observed to heat up, resulting in increased infrared emission by molecules including nitric oxide and carbon dioxide. These unique Heliophysics System Observatory observations demonstrate the substantial sensitivity of Earth's atmosphere to short- and long-term variability of the Sun. (Read more about the SDO and RHESSI research and the TIMED research.)

Imaging Magnetospheric Dynamics Tracks the Impact of Solar Disturbances

Imaging the rarified plasmas and magnetic fields of Earth's magnetosphere has long eluded scientists. The absence of global images has made the large-scale dynamics of the region much more difficult to unravel and understand. Recently two spacecraft within the Heliophysics System Observatory have turned their high-resolution cameras on the magnetosphere and directly observed its complex flows. The cameras on the Two Wide-Angle Imaging Neutral-Atom Spectrometers (TWINS) and IBEX both detect energetic neutral atoms (ENAs) rather than light. ENAs are created when fast moving protons hit neutral atoms. The two spacecraft observed the magnetosphere from different perspectives, providing a comprehensive stereo view during the April 5, 2010, geomagnetic disturbance. From outside, IBEX showed that the magnetosphere was immediately compressed by the impact of an interplanetary shock wave. About 15 minutes later, one of the TWINS spacecraft located inside the magnetosphere observed energetic particles trapped in the ring current, an electric current that appears 20,000 miles above the surface of Earth during geomagnetic disturbances. These new observations provide a new global perspective and highlight the importance of ENAs for remotely observing the impacts of interplanetary disturbances on Earth's magnetosphere. (Read more about this story.)

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Update to Multi-Year Performance Goal	
FY13 Update	This performance goal remains the same in FY13.
FY14	This performance goal remains the same in FY14.

Reported Annual Performance					
HE-12-4: Demonstrate planned progress in understanding how human society, technological systems, and the habitability of planets are affected by solar variability interacting with planetary magnetic fields and atmospheres. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.					
Contributing Theme:		Heliophysics			
Contributing Program(s):		Multiple Programs			
FY07	**FY08**	**FY09**	**FY10**	**FY11**	**FY12**
7ESS19 Green	**8HE03 Green**	**9HE6 Green**	**10HE06 Green**	**HE-11-4 Green**	**HE-12-4 Green**
Planned Annual Performance					
FY13 Update	HE-13-4: Demonstrate planned progress in understanding how human society, technological systems, and the habitability of planets are affected by solar variability interacting with planetary magnetic fields and atmospheres. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.				
FY14	HE-14-4: Demonstrate planned progress in understanding how human society, technological systems, and the habitability of planets are affected by solar variability interacting with planetary magnetic fields and atmospheres. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.				

Reported Annual Performance					
No annual performance goal in FY12.					
Contributing Theme:		Heliophysics			
Contributing Program(s):		Living with a Star			
FY07	**FY08**	**FY09**	**FY10**	**FY11**	**FY12**
7ESS14 Yellow	**8HE06 Green**	**None**	**None**	**None**	**None**
Planned Annual Performance					
FY13 Update	HE-13-2: Achieve mission success criteria for the Solar Dynamics Observatory (SDO).				
FY14	No annual performance goal in FY14.				

Reported Annual Performance	
No annual performance goal in FY12 or trended performance.	
Contributing Theme:	Heliophysics
Contributing Program(s):	Living with a Star

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Planned Annual Performance	
FY13 Update	No annual performance goal in FY13.
FY14	HE-14-2: Achieve mission success criteria for Van Allen Probes Mission.

Reported Multi-Year Performance

Multi-Year Performance Goal 2.2.2.2: By 2015, launch two missions in support of objective 2.2.2.

FY11
Green
FY12
Green

The purpose of this performance goal is to design, develop, and launch satellites in support of objective 2.2.1, as outlined in the NASA Science Mission Directorate's 2010 Science Plan. The launch of these missions will provide not only critical new knowledge but will also broaden the distribution and capabilities of observation posts that are needed to study the full range of Sun-solar system connections. This combination of new heliophysics knowledge and a well-supported constellation of operating missions can facilitate the path towards an operational capability to predict space weather.

NASA launched the first mission in support of this performance goal, the two-spacecraft Van Allen Probes. NASA plans to launch the second mission, MMS, by 2015.

Update to Multi-Year Performance Goal	
FY13 Update	This performance goal remains the same in FY13.
FY14	This performance goal remains the same in FY14.

Reported Annual Performance					
HE-12-2: Complete the Magnetospheric MultiScale (MMS) Systems Integration Review.					
Contributing Theme:		Heliophysics			
Contributing Program(s):		Solar Terrestrial Probes			
FY07	**FY08**	**FY09**	**FY10**	**FY11**	**FY12**
7ESS15 Red	**8HE02 Green**	**9HE2 Green**	**10HE02 Green**	**HE-11-2 Green**	**HE-12-2 Green**
Planned Annual Performance					
FY13 Update	HE-13-3: Complete integration of the payload to the Magnetospheric Multiscale (MMS) satellite #1 (of four).				
FY14	HE-14-3: Complete Magnetospheric MultiScale (MMS) Observatory #4 Environmental Test.				

Reported Annual Performance					
HE-12-3: Complete the Geospace Radiation Belt Storm Probes Launch Readiness Review.					
Contributing Theme:		Heliophysics			
Contributing Program(s):		Living with a Star			
FY07	**FY08**	**FY09**	**FY10**	**FY11**	**FY12**
7ESS16 Green	**8HE04 Green**	**9HE3 Green**	**10HE03 Green**	**HE-11-3 Green**	**HE-12-3 Green**
Planned Annual Performance					
FY13 Update	No annual performance goal in FY13.				
FY14	No annual performance goal in FY14.				

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Comments	NASA successfully launched the Geospace Radiation Belt Storm Probes spacecraft, now called the Van Allen Probes, on August 30, 2012. The Van Allen Probes will contribute scientific data in support of performance goals 2.2.1.1 and 2.2.2.1 through FY 2014, when it will conclude its prime mission. At that time NASA will evaluate whether the Van Allen Probes achieved its mission success criteria.

Reported Annual Performance	
No annual performance goal in FY12 or trended performance.	
Contributing Theme:	Heliophysics
Contributing Program(s):	Living with a Star
Planned Annual Performance	
FY13 Update	HE-13-6: Complete the Solar Orbiter Collaboration Mission Confirmation Review.
FY14	HE-14-5: Complete Solar Orbiter Collaboration Heavy Ion Sensor (HIS) Instrument Critical Design Review.

Reported Annual Performance					
No annual performance goal in FY12.					
Contributing Theme:		Heliophysics			
Contributing Program(s):		Living with a Star			
FY07	**FY08**	**FY09**	**FY10**	**FY11**	**FY12**
None	**None**	**None**	**10HE04 Green**	**None**	**None**
Planned Annual Performance					
FY13 Update	No annual performance goal in FY13.				
FY14	HE-14-6: Complete Solar Probe Plus Preliminary Design Review.				

Reported Multi-Year Performance

Multi-Year Performance Goal 2.2.3.1: Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base. (In support of objective 2.2.3: "Maximize the safety and productivity of human and robotic explorers by developing the capability to predict extreme and dynamic conditions in space.")

FY11
Green
FY12
Green

During FY 2012, NASA supported the development of the Nation's scientific capabilities in this heliophysics science area through many efforts, including early career fellowships, Living With a Star Targeted Research and Technology Programs, and the integrated Space Weather Analysis system that captures and makes publically available NASA/Heliophysics real-time data.

New Observations Enable Advanced Detection of Sunspots Beneath the Sun's Surface

Long visible to the (protected) human eye as dark blemishes on the solar disk, sunspot regions are the birthplaces of massive, highly energetic solar explosions (flares and coronal mass ejections). When these eruptions reach Earth, they can generate beautiful aurorae but also can wreak havoc on satellites, communications, and electric power grids. A key goal of the Heliophysics program is to reliably predict the occurrence and strength of these

	eruptions, long before they reach our vulnerable planet. For longer-term forecasting, scientists must reliably detect sunspot regions well before they emerge onto the surface from deep within the Sun. Scientists know that sunspot regions are planet-sized bundles of strong, twisted magnetic field that rise like bubbles until they breach the solar surface, but until recently they could not predict when or where they would appear. Exciting new research with instruments onboard two NASA spacecraft, the long-serving Solar and Heliospheric Observatory (SOHO) and the newer SDO, has detected sunspot regions while they are still submerged and invisible to ordinary telescopes. The analysis technique, called "time-distance helioseismology," is similar to an approach widely used in earthquake studies. Just as seismic waves traveling through Earth reveal the inner workings of Earth, sound waves traveling through the Sun can reveal what is inside the star. Submerged magnetic-field bundles affect the Sun's inner acoustics in ways that can now be calculated, revealing the presence of hidden sunspot regions just as the medical sciences use ultrasound scans. This revolutionary technique is most sensitive to large sunspot regions when they are located about 60,000 kilometers (nearly five times Earth's diameter) beneath the Sun's surface, providing up to two days' advance notice that a strong magnetic field is about to emerge. Because larger sunspot regions are more likely to produce the most powerful solar explosions, this research holds great promise for enabling adverse space weather to be forecast in time to mitigate or prevent harmful effects, days before the explosions will actually occur. (Read more about this story.) **Unraveling the Mystery of Disappearing Radiation Belt Electrons** The content of very high-energy electrons that populate the Van Allen Radiation Belts regularly increases and decreases due to changes in the solar wind. Understanding how charged particles leave the belts is critical to developing accurate models that will predict hazards to spacecraft and astronauts. Dramatic dropouts in the Van Allen belts' content can occur at various times during magnetic storms, in some cases when electrons, pushed by waves, rain on the atmosphere. A team of researchers has now unraveled another major cause of electron dropouts. Using measurements from a network of satellites passing through the radiation belts (the Time History of Events and Macroscale Interactions during Substorms (THEMIS) satellite and the Geostationary Operational Environmental Satellite (GOES) probes in equatorial orbit and the Polar Orbiting Environmental Satellites (POES) in low-altitude polar orbit) the team showed that, at the onset of a geomagnetic storm, the majority of lost electrons are swept out into interplanetary space instead of raining into the atmosphere. (Read more about this story.)

Update to Multi-Year Performance Goal	
FY13 Update	This performance goal remains the same in FY13.
FY14	This performance goal remains the same in FY14.

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Reported Annual Performance					
HE-12-5: Demonstrate planned progress in maximizing the safety and productivity of human and robotic explorers by developing the capability to predict the extreme and dynamic conditions in space. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.					
Contributing Theme:		Heliophysics			
Contributing Program(s):		Multiple Programs			
FY07	**FY08**	**FY09**	**FY10**	**FY11**	**FY12**
7ESS20 Green	**8HE05 Green**	**9HE8 Green**	**10HE08 Green**	**HE-11-5 Green**	**HE-12-5 Green**

Planned Annual Performance	
FY13 Update	HE-13-5: Demonstrate planned progress in maximizing the safety and productivity of human and robotic explorers by developing the capability to predict the extreme and dynamic conditions in space. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.
FY14	HE-14-7: Demonstrate planned progress in maximizing the safety and productivity of human and robotic explorers by developing the capability to predict the extreme and dynamic conditions in space. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.

Reported Multi-Year Performance

Multi-Year Performance Goal 2.2.3.2: By 2017, launch at least two missions in support of objective 2.2.3.

FY11
Green
FY12
Green

The purpose of this performance goal is to design, develop, and launch satellites in support of objective 2.2.1, as outlined in the NASA Science Mission Directorate's 2010 Science Plan. The launch of these missions will provide not only critical new knowledge but will also broaden the distribution and capabilities of observation posts that are needed to study the full range of Sun-solar system connections. This combination of new heliophysics knowledge and a well-supported constellation of operating missions can facilitate the path towards an operational capability to predict space weather.

NASA launched the first mission in support of this performance goal, the two-spacecraft Radiation Belt Storm Probes, on August 30, 2012. NASA renamed the mission Van Allen Probes once the spacecraft were on orbit and operational.

The second mission, Solar Orbiter, a collaborative mission with the European Space Agency, is planned for launch in 2017, and will venture closer to the Sun than any previous mission. Solar Orbiter will explore the near-Sun environment to improve the understanding of the origins of the solar wind streams and the heliospheric magnetic field, the sources, acceleration mechanisms, and transport processes of solar energetic particles, and the evolution of coronal mass ejections in the inner heliosphere. The mission will provide better insight into the evolution of sunspots, active regions, coronal holes, and other solar features and phenomena.

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Update to Multi-Year Performance Goal	
FY13 Update	This performance goal remains the same in FY13.
FY14	This performance goal remains the same in FY14.

Reported Annual Performance					
HE-12-3: Complete the Geospace Radiation Belt Storm Probes Launch Readiness Review.					
Contributing Theme:		Heliophysics			
Contributing Program(s):		Living with a Star			
FY07	**FY08**	**FY09**	**FY10**	**FY11**	**FY12**
7ESS16 Green	**8HE04 Green**	**9HE3 Green**	**10HE03 Green**	**HE-11-3 Green**	**HE-12-3 Green**
Planned Annual Performance					
FY13 Update	No annual performance goal in FY13.				
FY14	No annual performance goal in FY14.				
Comments	NASA successfully launched the Geospace Radiation Belt Storm Probes spacecraft, now called the Van Allen Probes, on August 30, 2012. The Van Allen Probes will contribute scientific data in support of performance goals 2.2.1.1 and 2.2.2.1 through FY 2014, when it will conclude its prime mission. At that time NASA will evaluate whether the Van Allen Probes achieved its mission success criteria.				

Reported Annual Performance	
No annual performance goal in FY12 or trended performance.	
Contributing Theme:	Heliophysics
Contributing Program(s):	Living with a Star
Planned Annual Performance	
FY13 Update	HE-13-6: Complete the Solar Orbiter Collaboration Mission Confirmation Review.
FY14	HE-14-5: Complete Solar Orbiter Collaboration Heavy Ion Sensor (HIS) Instrument Critical Design Review.

Reported Annual Performance					
No annual performance goal in FY12.					
Contributing Theme:		Heliophysics			
Contributing Program(s):		Living with a Star			
FY07	**FY08**	**FY09**	**FY10**	**FY11**	**FY12**
None	**None**	**None**	**10HE04 Green**	**None**	**None**
Planned Annual Performance					
FY13 Update	No annual performance goal in FY13.				
FY14	HE-14-6: Complete Solar Probe Plus Preliminary Design Review.				