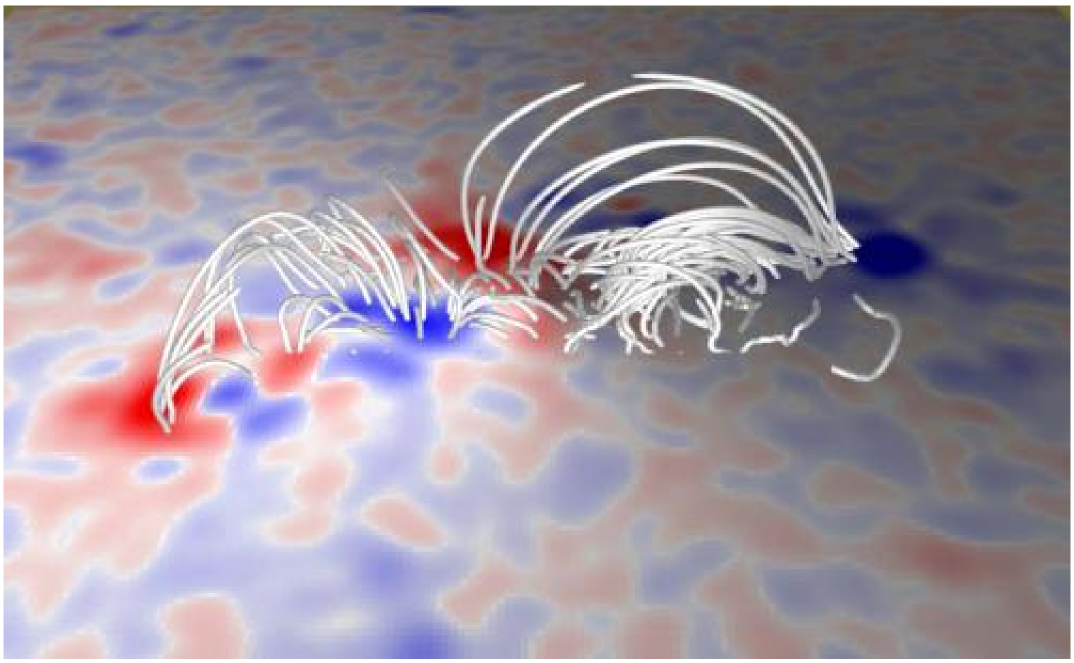
Year three: NASA SDO mission highlights

February 13 2013, by Karen C. Fox



White lines represent magnetic field lines looping up out of the sun's surface in this image from SDO's Helioseismological and Magnetic Imager (HMI). Credit: NASA/SDO/HMI

On Feb. 11, 2010, NASA launched an unprecedented solar observatory into space. NASA's Solar Dynamics Observatory (SDO) flew up on an Atlas V rocket, carrying instruments that scientists hoped would revolutionize observations of the sun. If all went according to plan, SDO would provide incredibly high-resolution data of the entire solar disk almost as quickly as once a second.

When the science team released its first images in April of 2010, SDO's data exceeded everyone's hopes and expectations, providing stunningly detailed views of the sun. In the three years since then, SDO's images have continued to show breathtaking pictures and movies of eruptive events on the sun. Such imagery is more than just pretty, they are the very data that scientists study. By highlighting different wavelengths of light, scientists can track how material on the sun moves. Such movement, in turn, holds clues as to what causes these giant explosions, which, when Earth-directed, can disrupt technology in space.

In its third year of observations, however, SDO has also opened up several new, unexpected doors to scientific inquiry. Over the last year scientists spent much time poring over data from comet observations. Comets that travel close to the sun – known as sun-grazers—have long been observed as they move toward the sun, but the view was always obscured by the sun's bright light when the comets got too close. But SDO has now captured images of two comets as they passed close to the sun.

In December 2011, Comet Lovejoy swept right through the sun's corona, with its long tail streaming behind it. SDO sent back pictures of the comet's long tail being buffeted by systems around the sun. Such comet tails move in response to the sun's otherwise invisible magnetic field, so they can also act as tracers of the complex magnetic field higher up in the corona, offering scientists a unique way of observing movement there. Observations of the comet's long trail of water vapor and the material its lost, as well as how it vaporizes in the intense radiation of the sun could also be used to study atomic material and their ratios in the corona. SDO's third year, therefore, brought two research communities together: comet researchers who can use solar observations for their studies and solar scientists who can use comet observations to study the sun.

One of the highlights of NASA's Solar Dynamics Observatory (SDO) during its third year in space: observations of Venus' transit across the Sun. This image was taken just as Venus was leaving the disk of the sun at 12:15 a.m. EDT on Jun. 6, 2012. Credit: NASA/SDO/HMI

The second novel highlight of SDO's third year occurred on June 5, 2012, when Venus crossed in front of the sun, as viewed from Earth – an occurrence that will not happen again for more than 100 years. SDO cameras trained on the transit to help calibrate its instruments and to learn more about Venus's atmosphere. Since the points at which Venus first touched and later left the sun are known down to minute detail, SDO could use this information to make sure its images are oriented to true solar north – calibrating its orientation to within a tenth of a pixel. Scientists also recorded how the sun's extreme ultraviolet light traveled through Venus's atmosphere in order to learn more about what elements exist around the planet.

The third new area of SDO data came from an always-planned source, the helioseismic and magnetic imager (HMI). The instrument provides real time maps of magnetic fields of the entire surface of the sun, showing how strong they are and – for the first time ever—in which direction they are pointing. Since HMI is providing a type of data never before collected, and so it has opened up a whole new area of inquiry. Changing and realigning magnetic fields are at the heart of the sun's eruptions, so this too is a crucial set of data. Scientists have spent time over the last year to figure out how to best create visual maps from the data – as well as how to interpret them. The HMI images have been affectionately referred to as "hedgehog pictures" since they show spiky quill like lines pointing out of – or in toward – the sun.

Studying such complex magnetic motions inside the sun can help scientists understand the complex magnetic fields around the sun, which lead to the eruptions that can cause space weather effects near Earth and other objects in the solar system. Ultimately research into these constantly changing magnetic fields may lead to advance warning of such activity, which can send radiation, particles, and magnetic fields toward Earth and sometimes disrupt technology at Earth and other planets.

SDO is the first mission in a NASA's Living With a Star program, the goal of which is to develop the scientific understanding necessary to address those aspects of the sun-Earth system that directly affect our lives and society. NASA's Goddard Space Flight Center in Greenbelt, Md. built, operates, and manages the SDO spacecraft for NASA's Science Mission Directorate in Washington, D.C.

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Provided by NASA's Goddard Space Flight Center

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