Solar Dynamics Observatory?an eye on the Sun

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One month after its successful launch, NASA's Solar Dynamics Observatory has begun capturing high-resolution images of solar phenomena at 10-second intervals. The imaging technique makes use of advanced new mirrors originally developed to build faster computer chips, but adapted for one of the three main instruments on board the SDO, the Atmospheric Imaging Assembly.

The AIA instrument consists of an array of four telescopes that will provide a view of the Sun of unprecedented breadth and depth, taking full-disk images at 10 different wavelengths every 10 seconds. Each image will be 4096 pixels by 4096 pixels, described as "almost IMAX quality" by Lawrence Livermore National Laboratory, where the technology was developed using a technique called extreme ultraviolet lithography.

NASA launched SDO on February 11 from Launch Complex 41 at the Kennedy Space Center aboard an Atlas V launch vehicle. Eighty-seven minutes later, the solar panels of SDO successfully deployed.

The launch of the SDO is epochal in the study of heliophysics. Its predecessor, the Solar and Heliospheric Observatory (SOHO) has been the flagship for solar physics for almost two decades. SDO will take over that role, using newer and more powerful instruments to probe the inner workings of the Sun. In addition to the AIA, these include the Extreme Ultraviolet Variability Experiment (EVE) and the Helioseismic and Magnetic Imager (HMI).

EVE is designed to monitor variations in the energy radiated by the Sun. Telescopes on the Earth have studied the Sun's light production for centuries, but the Earth's atmosphere obscures most of the Sun's rays. Solar radiation occurs across the electromagnetic spectrum, and only telescopes in space can study the high-energy X-ray and ultraviolet radiation that are the signatures of high-temperature physics at the Sun's surface.

Using a technique called helioseismology, a process that traces the path of sound waves within the Sun, HMI sees the inside of the Sun. Specifically, HMI will look at how processes that occur inside the Sun cause the magnetic fields that are seen on the surface. It will also produce data to study the magnetic fields found in the Sun's corona, or outer atmosphere. The goal is to enhance our understanding of the magnetic activity which is a precursor to high solar activity that can harm electronics and humans in orbit.

The AIA's primary function is to observe the Sun's corona. With four cameras working in tandem, it will give the most precise view of the solar corona available. In conjunction with ground observations and SDO's other instruments, AIA will produce data to study the very hot gas it holds. Ultimately, its goal is to help development of forecasting tools needed to predict solar activity that will affect Earth.

SDO is the first satellite of NASA's Living With a Star (LWS) program. Every second of every day, the Sun emits what is called solar wind, which constantly bombards the Earth with charged particles, or ions. Normally, the Earth's magnetic field is adequate protection from this onslaught, but a solar flare or coronal mass ejection—concentrations of high energy light or large clouds of ions, respectively—aimed at the Earth can cause anything from minor glitches in satellites to knocking out whole power grids on the Earth's surface, as happened to Canada's HydroQuebec power grid in 1989. The LWS program focuses on studying the causes of these events so they can be predicted and safeguarded against.

The SDO spacecraft itself is a powerful instrument.

Unlike SOHO, which is 5 light seconds (~932,000 miles or ~1,500,000 kilometers) away from the Earth, SDO is in a geosynchronous orbit around Earth, 22,000 miles up. The first advantage of being close is that less fuel is required to reach orbit. The second is that the data rate from SDO is far higher than SOHO's. SOHO would need an antenna as large as a football field to return the same amount of data to Earth from its position, compared to the SDO.

SDO will sending Earth 1.6 terabytes of data a day, 50 times the rate of any previous NASA mission. The annual data transmission, about one petabyte, is a hundred times as much data as all the written works in the Library of Congress.

Solar activity plays a key role in everyday life. Providing warmth to the planet is just one way it affects Earth's population. The energy emitted is capable of making a mockery of unprotected electronics as well as literally frying astronauts caught in a solar storm. Using satellites like the SDO to gain an understanding the processes that create solar storms will help avoid future devastating events.