German Aerospace Center

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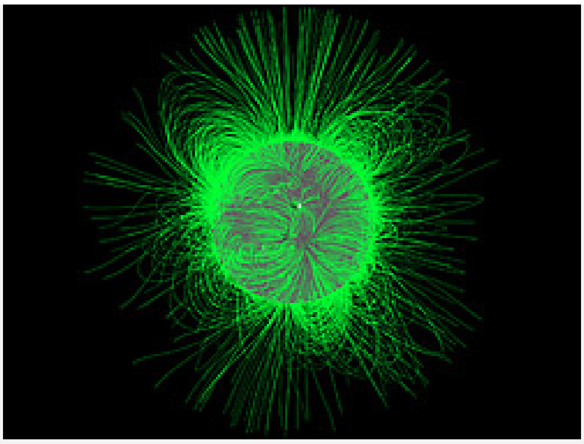
On the trail of space weather: SDO solar observatory launched successfully

11 February 2010



Magnetic field lines around the Sun

Beginning Thursday, 11 February 2010, our Sun is being monitored round the clock - the space-based Solar Dynamics Observatory (SDO) was launched successfully from Cape Canaveral on an Atlas V. The continuous stream of data supplied by this observatory will substantially improve our ability to forecast space weather. The German Aerospace Center (DLR) is supporting this NASA-led mission with the SDO Data Center at the Max-Planck-Institute for Solar System Research (MPS) in Katlenburg-Lindau.

Quality of solar images superior to HD television

SDO is scheduled to observe the Sun for a five-year period from its geosynchronous orbit at an altitude of 36,000 kilometres. Scientists are actually hoping to operate the mission throughout the duration of a complete sunspot cycle, which lasts for about 11 years. The quality of its solar images will be up to 10 times better than those of the HD television format (High Definition TV). SDO is the first mission of NASA's Living With a Star Program (LWS).

Solar wind and flares: challenges for mankind and technology

Without the Sun, life on Earth would be inconceivable – but its high-energy particles do have some negative impacts. These particles can cause navigation and communication satellites to fail, they pose a threat to astronauts and airline flight crews and can damage power grids by causing voltage surges.

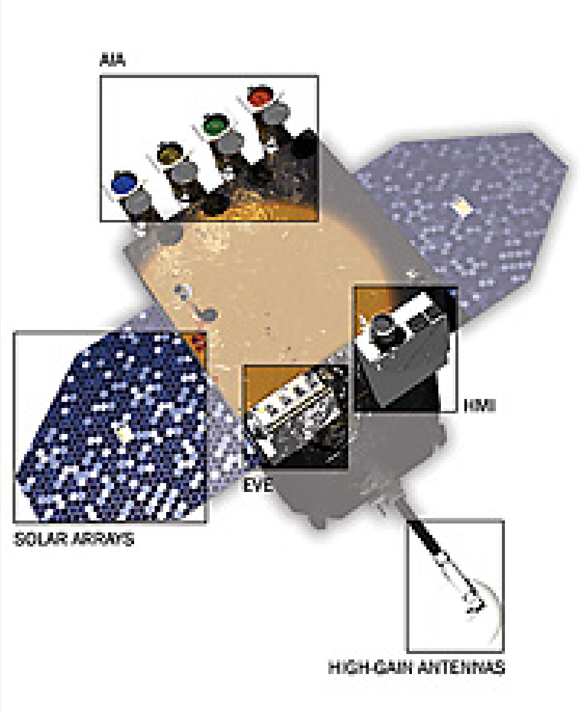
The Solar Dynamics Observatory (SDO)

These adverse factors are caused by massive explosions in the Sun's atmosphere, known as 'flares'. Other triggers include the river-like flows of electrically-charged particles – the solar wind – and coronal mass ejections (CMEs), during which billions of tons of solar material are expelled into interplanetary space. Although the particles of material ejected by CMEs usually take a few days to reach near-Earth space, some electrically-charged particles reach almost the speed of light. In addition, solar radiation travels at the speed of light, leaving roughly eight minutes between a solar event and its arrival on Earth. The areas most affected by these harmful solar outputs are near-Earth space and Earth's polar regions.

With data from the SDO, scientists and engineers will, in the future, be able to achieve substantial improvements in forecasting solar radiation, also known as 'space weather'. This will enable satellite operators, to switch their equipment to a secure mode whenever danger threatens, thereby protecting sensitive devices from damaging overloads and surges. When danger looms, astronauts in the International Space Station (ISS) take shelter in a specially-protected room.

HMI, AIA and EVE instruments observing the Sun

The SDO employs three instruments to observe the Sun. The Helioseismic and Magnetic Imager (HMI) operates in a similar way to an ultrasound unit and observes the interior of the Sun, as well its far side, which cannot be viewed from Earth. The reciprocal interaction between activities in the Sun's magnetic field and the processes within the solar corona that release energy are scrutinised by the Atmospheric Imaging Assembly (AIA), while the Extreme Ultraviolet Variability Experiment (EVE) continuously measures changes in solar radiation at the extreme end of the ultraviolet spectrum.



SDO – the satellite and its instruments

The instruments on the SDO, in particular EVE, capture a new image of the Sun every ten seconds. This generates vast quantities of data, amounting to about 1.5 terabytes or 1500 gigabytes per day. This is the equivalent of downloading 500,000 songs or 240 Hollywood films on DVD daily. To enable this vast volume of data to be used, the SDO transmits its data to its ground station in White Sands (New Mexico, USA), at a speed of up to 300 megabits (Mb) per second.

From there, the raw data are forwarded to the MPS Data Center in Germany, where they are compressed and processed. MPS takes this raw data and converts them into high-resolution maps of internal flows deep inside the Sun that scientists can then use. MPS also generates 3D maps of the Sun's coronal magnetic field and produces up-to-date tables indicating the total brightness of the Sun. These evaluations are then made available to researchers all around the world.

Ground control and management of the Solar Dynamics Observatory is now in the hands of the NASA Goddard Space Flight Center in Greenbelt (Maryland, USA). The mission costs of the SDO to the National Aeronautics and Space Administration (NASA) amount to approximately 870 million USD. DLR has financed the SDO Data Center with funds from Germany's Federal Ministry of Economics and Technology (Bundesministerium für Wirtschaft und Technologie; BMWi). Germany is investing about 1.5 million Euro in this mission. Other German partners on the SDO project include the Astrophysics Institute in Potsdam (AIP) and the Kiepenheuer Institute for Solar Physics (KIS) in Freiburg. MPS acts as a point of contact for all requests for data from German scientists.

Related Contacts

Diana Gonzalez
German Aerospace Center
Space Administration, Strategy and Communications
Tel: +49 228 447-388
Fax: +49 228 447-731
E-Mail: Diana.Gonzalez@dlr.de

Heiner Witte
German Aerospace Center
Space Administration, Space Science
Tel: +49 228 447-344
Fax: +49 228 447-745
E-Mail: Heiner.Witte@dlr.de
