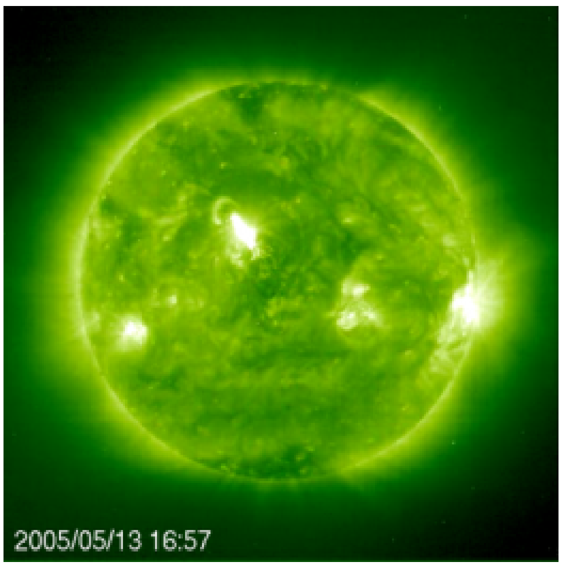
Scientists track solar eruption all the way from the Sun to the Earth (w/ Video)

April 14 2010, by Robert Massey



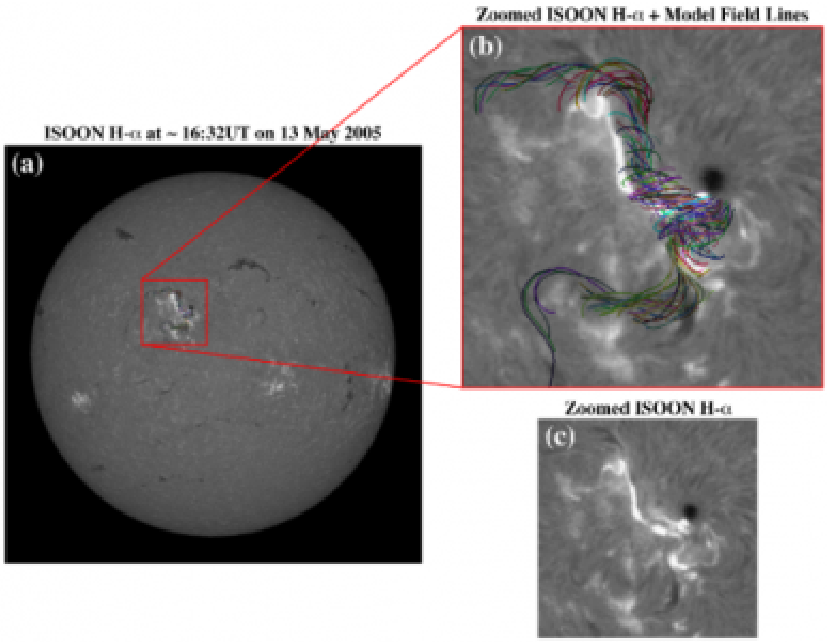
An image of the Sun taken in the extreme-ultraviolet (EUV) portion of the electromagnetic spectrum and shown in false colour by the Extreme-ultraviolet Imaging Telescope (EIT) aboard the SOlar and Heliospheric Observatory (SOHO). The active region responsible for the event can be seen by the associated dimming near the centre of the Sun's disc and the brightening of the active region itself just above and to the left of centre (North and East). Image: CDAW/ESA/NASA/Solar Physics.

(PhysOrg.com) -- An international group of solar and space scientists have built the most complete picture yet of the full impact of a large solar eruption, using instruments on the ground and in space to trace its journey from the Sun to the Earth. Dr Mario Bisi of Aberystwyth

University presented the team's results, which include detailed images and a movie, on Tuesday 13th April at the RAS National Astronomy Meeting in Glasgow.

Coronal mass ejections (CMEs) are giant eruptions of the Sun's atmosphere from its 'surface' which are ejected out into space. They are many times larger than the Earth and typically contain over a billion tonnes of matter. CMEs travel away from the Sun at speeds of up to several million kilometres an hour (between 200 and 2000+ kilometres per second) and can impact on comets, asteroids, and planets - including the Earth.

Our planet is normally protected from CMEs by the terrestrial magnetic field, but the twisted magnetic fields carried by CMEs can break through this protective shield, causing particles to stream down over the Earth's polar regions. They can also lead to displays of the northern and southern lights (aurora borealis and australis). But CMEs can also have less appealing consequences such as power outages on the ground, interference with communications, damage to Earth-orbiting satellites, as well as being a possible health risk to any astronauts who happen to be conducting a "space walk" at the time an event interacts with the Earth.



(a) Image of the disc of the Sun in the light of the hydrogen-alpha spectral line a couple of minutes after the onset of the event with model magnetic field lines superimposed. (b) A zoomed-in image of the active region concerned, again with a set of model magnetic field lines superimposed. (c) As in (b), but without the model superimposed showing the detail of the event in the image. Images taken using the Improved Solar Observing Optical Network (ISOON). Image: Predictive Science, Inc./Solar Physics.

The scientists came together to study one event in great detail in an attempt to gain an enhanced understanding of CMEs, to gain an insight into their prediction and more importantly, when and how they may interact with and cause effects on and in the vicinity of the Earth. After a painstaking analysis of the observations and measurements from all the different spacecraft and facilities on the ground, they have assembled an incredibly detailed picture.

They chose an eruption which lifted off from the Sun on the 13th May 2005 and headed in our direction. As it approached our planet, it interacted with the solar wind, the material which is constantly flowing out from the Sun at relatively steady rates. This particular CME deflected some of the solar wind northward as it headed in the direction of Earth and was itself slowed as a result of the solar wind ahead of it.

The mass expelled in the event was not that different from many other solar eruptions but its magnetic field was very intense, and as such, this event caused the largest geomagnetic storm (rapid changes in the shape and strength of the Earth's magnetic field) during the year 2005. At that time solar activity was in decline from the maximum period between the years 2002 and 2004 to the recent minimum between 2008 and 2010.

Data used to conduct this study came from many sources and in many forms. These included images of the Sun and its vicinity from instruments aboard the SOHO spacecraft; radio-burst data from the Wind spacecraft, GOES satellite, and ground-based instrumentation, solar wind measurements from the SOHO, ACE, and Wind spacecraft and measurements of the Earth's magnetosphere and ionosphere from the Cluster and IMAGE spacecraft and ground-based magnetometers.

At the start of the event the outburst was thought to be a 'simple CME', but the unprecedented coverage revealed it to be extremely complex, with many small parts which when looked at individually, make up the bigger picture from its launch through to its arrival at the Earth. The event was caused by multiple flare-type events near the solar surface which released magnetic energy and mass out into the solar wind in the form of the CME.

The material then travelled through interplanetary space out towards the Earth (in this phase it is described as an Interplanetary CME or ICME). With the magnetic field frozen inside it in the form of a 'flux rope', or 'magnetic cloud' (MC), when the ICME reached our planet it began to compress the Earth's magnetic field in to a distance of about 38000 km (in comparison, the field on the Sun-ward side would normally extend to 95000 km). The arrival of the CME also caused some minor effects on satellites and communications as well as wonderful auroral displays.

Dr Bisi sees the new analysis as a key step forward in our understanding of the way solar eruptions develop and affect the Earth. “We learned an enormous amount from the 2005 event. Even an apparently simple CME turned out to be incredibly complex. And the intense reaction of the Earth’s magnetic field to a fast but not particularly powerful event was a surprise.”

‘We’re now also much better prepared for future events and if nothing else know how to handle such a large amount of data. All of this adds to our knowledge of the way CMEs originate, develop, and sometimes even have an impact on everyday life.”

Provided by Royal Astronomical Society

Citation: Scientists track solar eruption all the way from the Sun to the Earth (w/ Video) (2010, April 14) retrieved 10 April 2024 from https://phys.org/news/2010-04-scientists-track-solar-eruption-sun.html