Solar storm forecasts for Earth improved with help from the public

18 September 2020

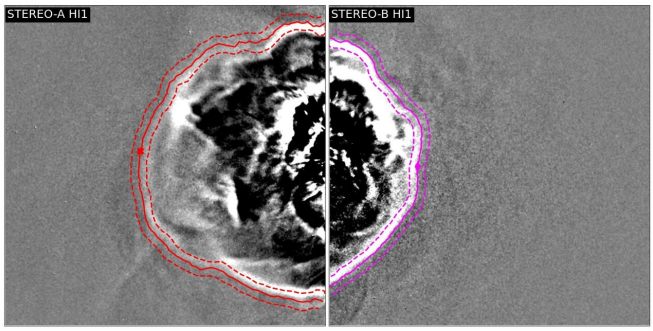

Image shows a CME erupting from the Sun's surface, captured from either side by imaging cameras on board the two STEREO spacecraft. The red and pink lines show the outline as traced by volunteers in the Solar Stormwatch project, which helped add important data about the size and shape of the CMEs into the new forecasting model. Credit: University of Reading/NASA

Solar storm analysis carried out by an army of citizen scientists has helped researchers devise a new and more accurate way of forecasting when Earth will be hit by harmful space weather.Scientists at the University of Reading added analysis carried out by members of the public to computer models designed to predict when coronal mass ejections (CMEs)—huge solar eruptions that are harmful to satellites and astronauts—will arrive at Earth.

The team found forecasts were 20% more accurate, and uncertainty was reduced by 15%, when incorporating information about the size and shape of the CMEs in the volunteer analysis. The data was captured by thousands of members of the public during the latest activity in the Solar Stormwatch citizen science project, which was devised by Reading researchers and has been running since 2010.

The findings support the inclusion of wide-field CME imaging cameras on board space weather monitoring missions currently being planned by agencies like NASA and ESA.

Dr. Luke Barnard, space weather researcher at the University of Reading's Department of Meteorology, who led the study, said: "CMEs are sausage-shaped blobs made up of billions of tonnes of magnetised plasma that erupt from the Sun's atmosphere at a million miles an hour. They are capable of damaging satellites, overloading power grids and exposing astronauts to harmful radiation.

"Predicting when they are on a collision course with Earth is therefore extremely important, but is made difficult by the fact the speed and direction of CMEs vary wildly and are affected by solar wind, and they constantly change shape as they travel through space.

"Solar storm forecasts are currently based on observations of CMEs as soon as they leave the Sun's surface, meaning they come with a large degree of uncertainty. The volunteer data offered a second stage of observations at a point when the CME was more established, which gave a better idea of its shape and trajectory.

"The value of additional CME observations demonstrates how useful it would be to include cameras on board spacecraft in future space weather monitoring missions. More accurate predictions could help prevent catastrophic damage to our infrastructure and could even save lives."

In the study, published in *AGU Advances*, the scientists used a brand new solar wind model, developed by Reading co-author Professor Mathew Owens, for the first time to create CME forecasts.

The simplified model is able to run up to 200 simulations—compared to around 20 currently used by more complex models—to provide improved estimates of the solar wind speed and its impact on

the movement of CMEs, the most harmful of which can reach Earth in 15-18 hours.

Adding the public CME observations to the model's predictions helped provide a clearer picture of the likely path the CME would take through space, reducing the uncertainty in the forecast. The new method could also be applied to other solar wind models.

The Solar Stormwatch project was led by Reading co-author Professor Chris Scott. It asked volunteers to trace the outline of thousands of past CMEs captured by Heliospheric Imagers—specialist, wide-angle cameras—on board two NASA STEREO spacecraft, which orbit the Sun and monitor the space between it and Earth.

The scientists retrospectively applied their new forecasting method to the same CMEs the volunteers had analysed to test how much more accurate their forecasts were with the additional observations.

Using the new method for future solar storm forecasts would require swift real-time analysis of the images captured by the spacecraft camera, which would provide warning of a CME being on course for Earth several hours or even days in advance of its arrival.

More information: *AGU Advances*, DOI: 10.1029/2020AV000214

Provided by University of Reading