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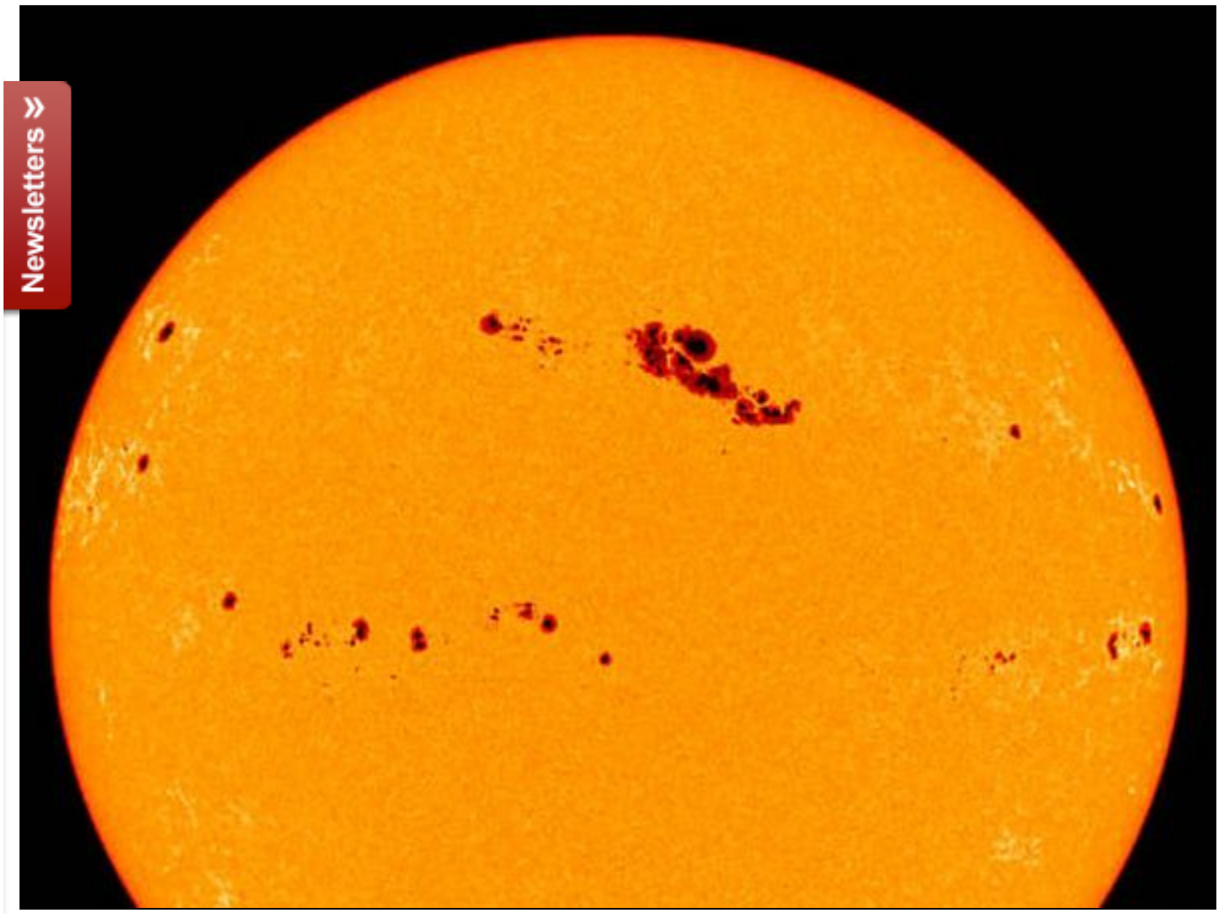
# Sunspots Can Now Be Predicted Days in Advance

New technique may improve solar-storm forecasts, experts say.




A SOHO picture of a sunspot grouping in September 2000.

***Image courtesy SOHO/ESA/NASA***

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**Sound waves from deep inside the sun can allow astronomers to predict**

**the appearance of sunspots days in advance—possibly leading to better forecasts of hazardous solar storms, a new study says.**

Sunspots are regions on the sun's surface that are cooler than the surrounding areas and so appear darker. (See sunspot pictures: "Sharpest View Yet in Visible Light.")

The spots form due to intense magnetic activity, and other magnetically driven solar events—such as flares and coronal mass ejections (CMEs)—tend to erupt from areas where sunspots appear.

When solar flares and CMEs are aimed at Earth, they send clouds of charged particles from the sun racing toward our planet.

As these particles interact with our magnetic field, they create geomagnetic storms that can pose hazards to astronauts and spacecraft in orbit as well as to power grids and telecommunications equipment on the ground. (See "As Sun Storms Ramp Up, Electric Grid Braces for Impact.")

Knowing when and where sunspots—and any associated flares and CMEs—will form may therefore be key to predicting solar storms.

"With our technique, we can detect sunspot regions 60,000 kilometers [37,282 miles] below the [sun's] surface, and this gives us one to two days heads-up before they appear on the solar disc," said study leader Stathis Ilonidis, an astronomer at Stanford University in California.

"Up to now, sunspot regions could not be anticipated in advance, so we hope that our results will improve space-weather forecasts."

**Sunspots Linked to Sound Wave Anomalies**

In much the same way geologists explore the inside of Earth using seismic waves, the new method uses sound waves and their vibrations to probe the interior of the sun.

(Related: "Sunlike Star Vibrations Seen for First Time.")

Although the method is yet to be tested in real time, Ilonidis and his team used past Doppler observations from the NASA/ESA Solar and Heliospheric Observatory, or SOHO, spacecraft to find the distinctive acoustic-wave signatures of emerging sunspots while the solar surface was still unblemished.

The team looked at data for four regions on the sun that eventually became active and nine regions that stayed quiet. In the active regions, the data showed that sound waves traveled a wee bit faster when they crossed magnetic structures deep in the sun.

"We can measure the time taken by acoustic waves to propagate from one location to another, and it turns out the total travel time for this particular distance [inside the sun] is about an hour," Ilonidis said.

"If, however, the waves cross a sunspot region along their path, they propagate a little faster inside the sunspot region, so the total travel time becomes a little shorter, by about 12 to 16 seconds."

The faster-moving acoustic signals were detected down to depths of nearly 40,000 miles (65,000 kilometers).

Since the magnetic structures that produce sunspots travel upward at speeds between 0.2 and 0.4 mile (0.3 and 0.6 kilometer) a second, the scientists knew the spots should emerge on the solar surface a day or two later—and the data showed that to be the case.

(Related: "Sun Headed Into Hibernation, Solar Studies Predict.")

IIonidis said he never expected that his team would be able to detect such a strong, clear signal of sunspots so far in advance, and he believes this new knowledge of the sun's clockwork will have practical benefits.

"I am really excited about the potential applications of our work," Ilonidis said, "and I hope that one day we will be able to utilize the results and provide useful warnings about upcoming severe space-weather events."

*The sunspot-prediction study appears in this week's issue of the journal* Science.