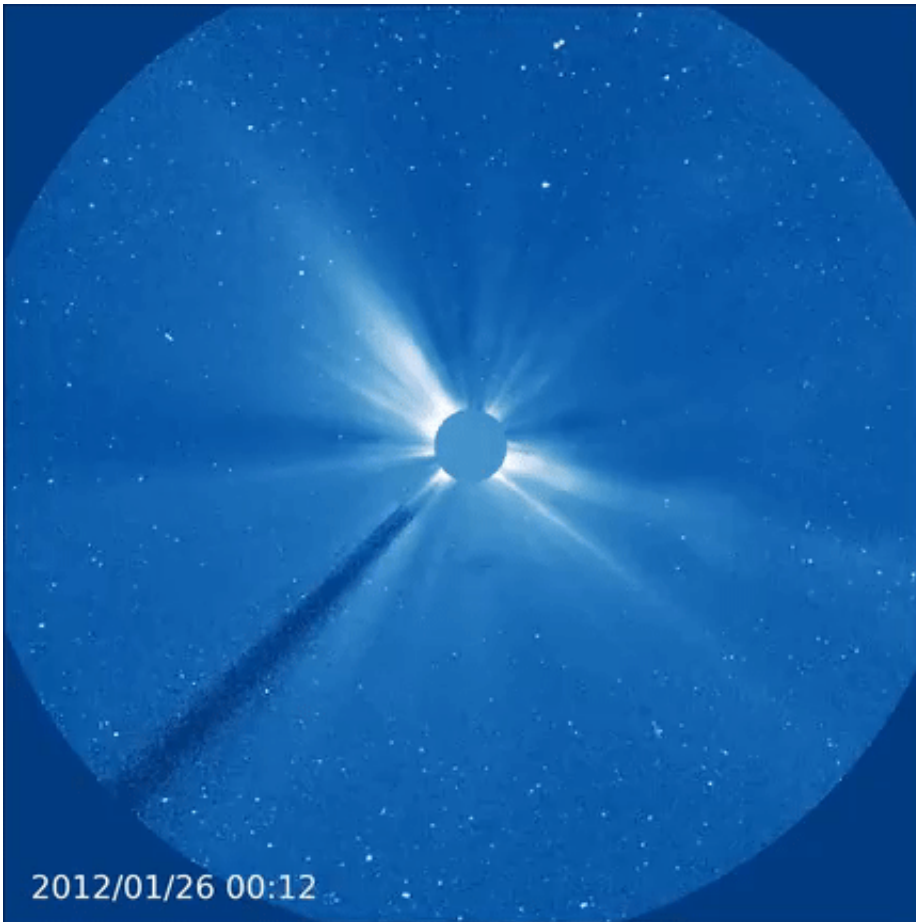


Solar cycle 25: The sun wakes up

October 30 2020



This impressive burst of energetic stellar activity was captured on 26 January 2012 by the LASCO cameras C2 and C3 onboard the ESA/NASA Solar and Heliospheric Observatory (SOHO). First, a huge Coronal Mass Ejection (CME) bursts from the Sun, flinging vast masses of stellar material approximately 1200 km per second across the Solar System. It is followed by a couple of smaller and slower CMEs estimated to be travelling at 200-400 km per second. A final CME blasts out at the end of the video, but this time it is directed at Earth. Such events are called “Halo” Coronal Mass Ejections because unlike those that are seen side-on, flung from the Sun and appearing to travel to the left or right, Earth-directed

CME's look like a ring of material that gets bigger and bigger. Once it strikes, fragments of a second later, a radiation storm disrupts instruments onboard spacecraft in the way, seen here as the chaotic 'sparkling' disturbances that beset the image. Credit: SOHO (ESA & NASA) - Brendan Gallagher

The sun has entered its 25th solar cycle and is about to wake up. For the last few years our star has been pretty sleepy, with few sunspots, bright flares or massive ejections of magnetized plasma emanating from its surface. This quiet period is known as the solar minimum, but things are starting to heat up again.

Experts on the Solar Cycle 25 Prediction Panel recently announced that the sun has officially entered a new cycle, its 25th since we've had enough data to reliably recognize them. While we can expect space weather to get more exciting in the next few years, with peak [sunspot activity](#) expected in 2025, the panel came to the consensus that this next cycle will be very similar to the previous, both generally weaker than the average [solar cycle](#).

"While small and medium-sized [solar storms](#) are more likely during peak [solar activity](#)," explains Juha-Pekka Luntama, Head of ESA's Space Weather Office, "it is important to remember that individual large solar events, huge flares and coronal mass ejections, can happen at any point, independent of where we are in the solar cycle or how strong the cycle becomes."

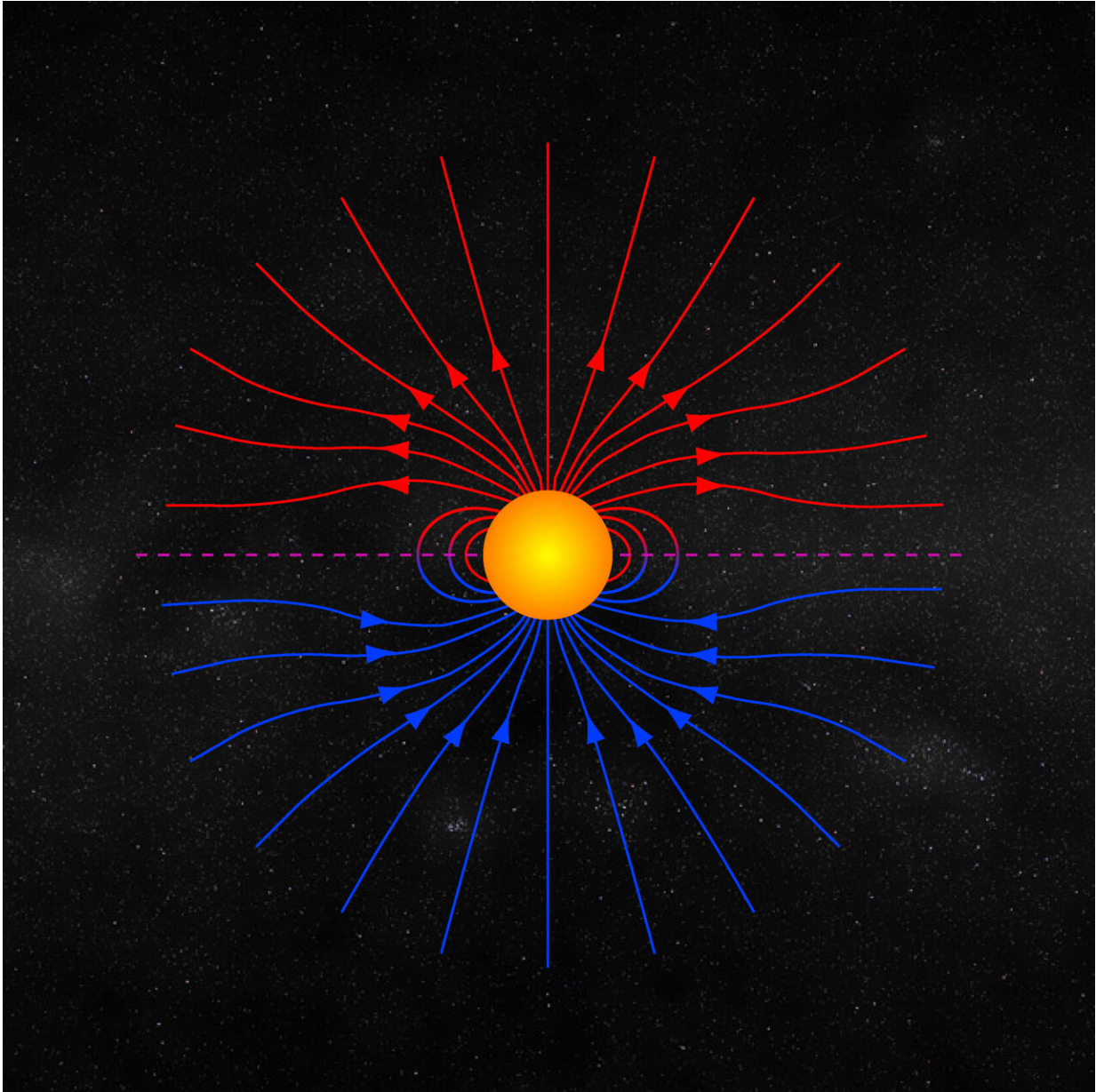
If such solar storms impact Earth, they can create geomagnetic storms in our magnetosphere. While good news for aurora hunters, these storms can disrupt and even damage power grids on Earth and satellites in orbit, and the vital services they provide.

Repetitive yet unpredictable

Like a bar magnet you may have used at school, the sun has a magnetic field with north and south poles, and [magnetic field lines](#) stretching out far beyond the star itself connecting the polar regions.

These poles have a mysterious tendency of switching places, with north becoming south and south becoming north, in a cycle that lasts on average about 11 years. The magnetic field flip occurs at the peak of each solar cycle, the solar maximum, when activity is highest. After the flip, activity slows down for the solar minimum and a new cycle begins.

We've been studying the sun for centuries, but the exact mechanism for this magnetic field flip remains a topic of scientific debate and theory. One of the key questions for ESA's Solar Orbiter mission is to understand what drives the solar cycle, and by looking at the polar regions we hope to learn more about how the magnetic field—which drives solar activity—is generated.



The ESA/NASA Ulysses mission has carried out unprecedented studies of the Sun's magnetic field and the way it is transported to outer space. It has found that close to the Sun, the magnetic field lines follow a specific pattern that varies with latitude, but at distances beyond 3 to 5 times the solar radius they become more uniform and have the same strength at all latitudes. Credit: ESA, image by C.Carreau

Sunspots are a useful tool to determine where the sun is in its cycle. The temporary dark spots on the solar surface are patches of intense magnetic activity, slightly cooler than the material around them and so appear darker than surrounding areas. These transient spots correlate directly to solar activity, as most solar flares and coronal mass ejections originate from sunspot groupings, also called "active regions".

Active regions, flares and ejections do follow the general sunspot cycle, meaning there are more during the solar maximum and less during the [solar minimum](#). However, giant flares and [coronal mass ejections](#) are statistically as likely to happen at any point, independent of the strength of a cycle. So, we must always be prepared for "bad" [space weather](#).

Cycle 25

The latest solar cycle, number 24, was determined to have ended in December 2019 when the average number of sunspots from this cycle reached a minimum and the first sunspots of the new cycle began to emerge.



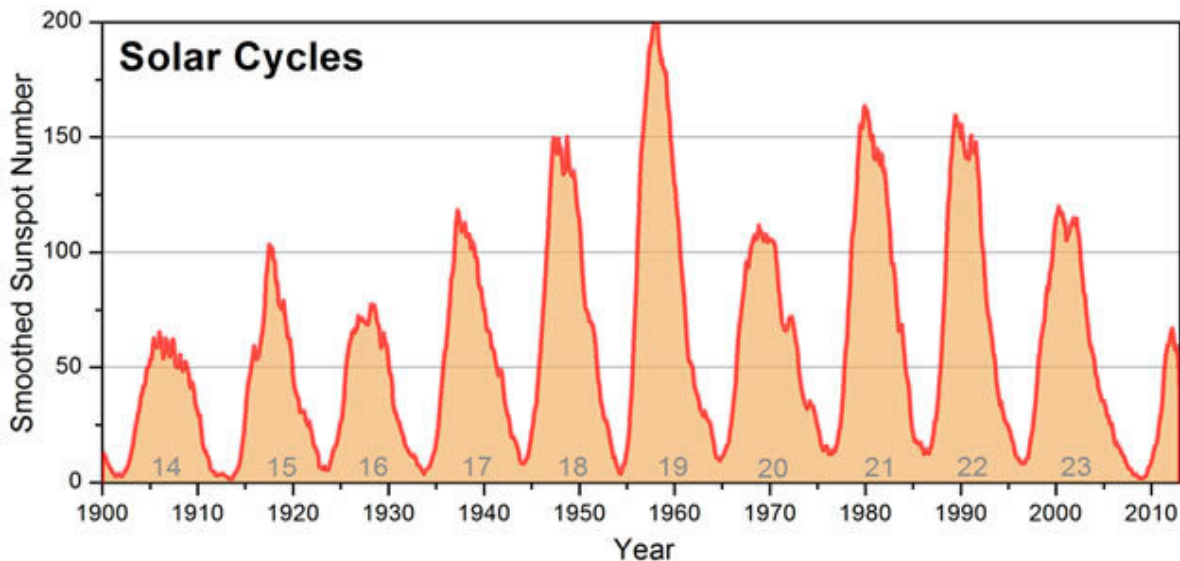
SOHO sees sunspot, 22 October 2003. Credit: European Space Agency

A new solar cycle is considered to start when new spots emerging at mid-latitudes on the sun's surface are opposite in magnetic polarity than the sunspots from the previous cycle. But because sunspot numbers fluctuate day-by-day and week-by-week, scientists use a rolling average meaning

it takes a few months for clear patterns in activity to become clear.

Predicting just how active the sun will get at the peak of a cycle is a notoriously difficult task. Just like weather on Earth, long term solar forecasts are difficult to gather, although we know there are general seasons of behavior.

Although the consensus on Solar Cycle 25 is that it will be similar to the last, this prediction comes with more uncertainty than most as solar cycle 25 comes after a general decline in peak solar activity. At this stage, the next solar [cycle](#) could continue the downward trend towards cycles with weaker than average activity, or it could mark the beginning of a series of more active cycles.



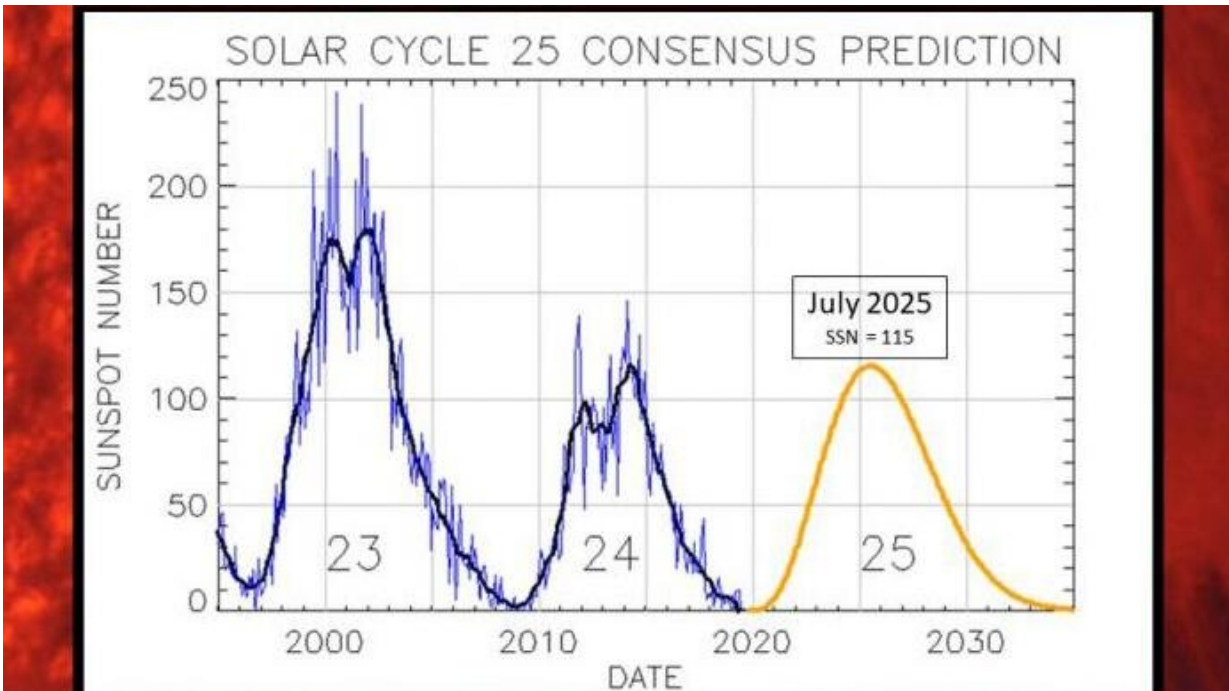
The number of sunspots on the surface of the sun increases and decreases in solar cycles of approximately 11 years. Solar minimum refers to the several years when the number of sunspots is lowest; solar maximum occurs in the years when sunspots are most numerous. Credit: NOAA Space Weather Products & Services

Earth impact

As solar activity picks up, the sun will emit more high-energy particulate radiation and matter into the Solar System. From our position on Earth, the third rock from the sun, any direct hit will have consequences for our [magnetic field](#)—the layer around Earth that protects us from the sun's outbursts—creating [geomagnetic storms](#).

These storms have the potential to cause serious problems for modern technological systems, disrupting or damaging satellites in space and the multitude of services—like navigation and telecoms—that rely on them. Geomagnetic storms can also black out power grids and radio communications, as well as creating a radiation hazard for astronauts in space, even serving potentially harmful doses of radiation to astronauts on future missions to the Moon or Mars.

Fortunately, such events do come with some warning—complex sunspot groups bubbling up from beneath the solar surface leaving dark patterns across the disk.



The NOAA/NASA co-chaired, international panel to forecast Solar Cycle 25 released their latest forecast for Solar Cycle 25. The panel agreed that Cycle 25 will be average in intensity and similar to Cycle 24. Credit: NOAA

While they can't be stopped, advance warning of oncoming solar storms would give operators of satellites, power grids and telecommunication systems, as well as space explorers, the time to take protective measures.

ESA's Space Safety program is planning a unique mission that will do just this. The Lagrange mission will make much-needed observations of the sun from a unique vantage point, the fifth Lagrange point. Watching our sun side-on, the Lagrange mission will get a preview of solar activity before it rotates into view of Earth, gathering the early data needed to provide such advance warnings.

Watching the sun from the fifth Lagrange point, the spacecraft will

detect solar events and their propagation toward Earth with higher accuracy than is possible today, transmitting data home and distributing it into ESA's Space Weather Service Network in near real-time, to generate warnings and forecasts.

Provided by European Space Agency

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