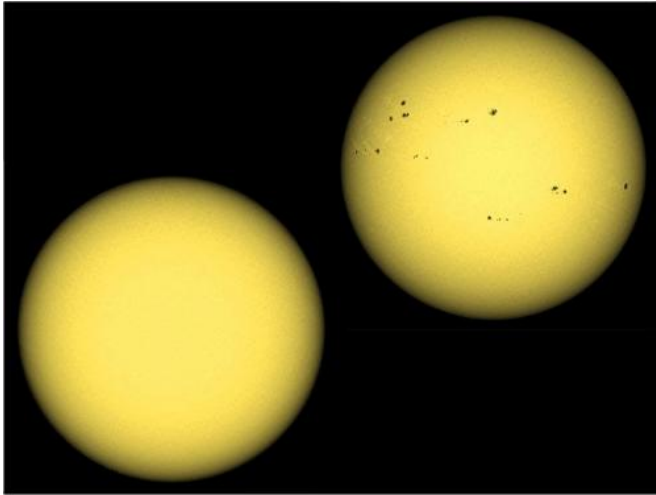


What's down with the Sun? Major drop in solar activity predicted

14 June 2011



The Sun viewed in visible light, at minimum phase (2006) and maximum phase (2001)

(PhysOrg.com) -- A missing jet stream, fading spots, and slower activity near the poles say that our Sun is heading for a rest period even as it is acting up for the first time in years, according to scientists at the National Solar Observatory (NSO) and the Air Force Research Laboratory (AFRL).

As the current sunspot [cycle](#), Cycle 24, begins to ramp up toward maximum, independent studies of the [solar](#) interior, visible surface, and the [corona](#) indicate that the next 11-year solar sunspot cycle, Cycle 25, will be greatly reduced or may not happen at all.

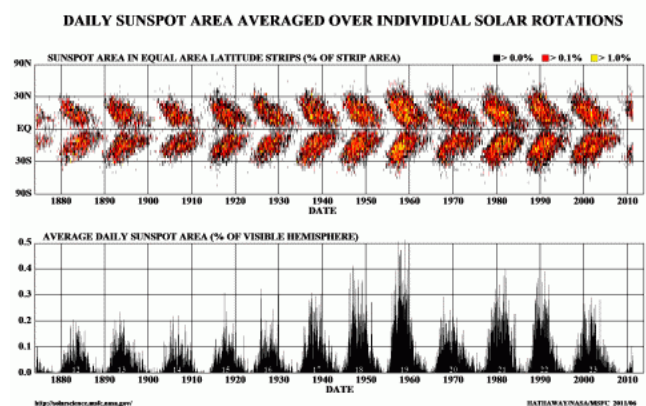
The results were announced at the [annual meeting](#) of the Solar Physics Division of the [American Astronomical Society](#), which is being held this week at New Mexico State University in Las Cruces.

"This is highly unusual and unexpected," Dr. Frank Hill, associate director of the NSO's Solar Synoptic

Network, said of the results. "But the fact that three completely different views of the [Sun](#) point in the same direction is a powerful indicator that the sunspot cycle may be going into hibernation."

Spot numbers and other solar activity rise and fall about every 11 years, which is half of the Sun's 22-year magnetic interval since the Sun's magnetic poles reverse with each cycle. An immediate question is whether this slowdown presages a second Maunder Minimum, a 70-year period with virtually no sunspots during 1645-1715.

Hill is the lead author on one of three papers on these results being presented this week. Using data from the Global Oscillation Network Group (GONG) of six observing stations around the world, the team translates surface pulsations caused by sound reverberating through the Sun into models of the internal structure. One of their discoveries is an east-west zonal wind flow inside the Sun, called the torsional oscillation, which starts at mid-latitudes and migrates towards the equator. The latitude of this wind stream matches the new spot formation in each cycle, and successfully predicted the late onset of the current Cycle 24.



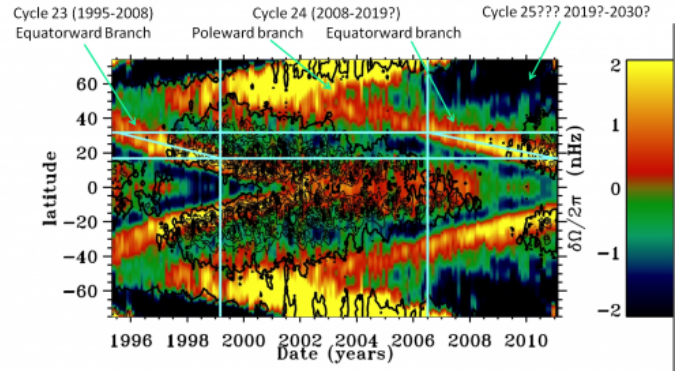
"Butterfly diagram" shows the position of sunspots over 12 solar cycles. Sunspots emerge over a range of

latitudes centered on migratory jet streams that follow a clear pattern, trending from higher latitudes to lower latitudes on the Sun. The active latitudes are associated with mobile zonal flows or "jet streams" that vary through the cycle.

"We expected to see the start of the zonal flow for Cycle 25 by now," Hill explained, "but we see no sign of it. This indicates that the start of Cycle 25 may be delayed to 2021 or 2022, or may not happen at all."

In the second paper, Matt Penn and William Livingston see a long-term weakening trend in the strength of sunspots, and predict that by Cycle 25 magnetic fields erupting on the Sun will be so weak that few if any sunspots will be formed. Spots are formed when intense magnetic flux tubes erupt from the interior and keep cooled gas from circulating back to the interior. For typical sunspots this magnetism has a strength of 2,500 to 3,500 gauss (Earth's magnetic field is less than 1 gauss at the surface); the field must reach at least 1,500 gauss to form a dark spot.

Using more than 13 years of sunspot data collected at the McMath-Pierce Telescope at Kitt Peak in Arizona, Penn and Livingston observed that the average field strength declined about 50 gauss per year during Cycle 23 and now in Cycle 24. They also observed that spot temperatures have risen exactly as expected for such changes in the magnetic field. If the trend continues, the field strength will drop below the 1,500 gauss threshold and spots will largely disappear as the magnetic field is no longer strong enough to overcome convective forces on the solar surface.



Latitude-time plots of jet streams under the Sun's surface show the surprising shutdown of the solar cycle mechanism. New jet streams typically form at about 50 degrees latitude (as in 1999 on this plot) and are associated with the following solar cycle 11 years later. New jet streams associated with a future 2018-2020 solar maximum were expected to form by 2008 but are not present even now, indicating a delayed or missing Cycle 25.

Moving outward, Richard Altrock, manager of the Air Force's coronal research program at NSO's Sunspot, NM, facilities has observed a slowing of the "rush to the poles," the rapid poleward march of magnetic activity observed in the Sun's faint corona. Altrock used four decades of observations with NSO's 40-cm (16-inch) coronagraphic telescope at Sunspot.

"A key thing to understand is that those wonderful, delicate coronal features are actually powerful, robust magnetic structures rooted in the interior of the Sun," Altrock explained. "Changes we see in the corona reflect changes deep inside the Sun."

Altrock used a photometer to map iron heated to 2 million degrees C (3.6 million F). Stripped of half of its electrons, it is easily concentrated by magnetism rising from the Sun. In a well-known pattern, new solar activity emerges first at about 70 degrees latitude at the start of a cycle, then towards the equator as the cycle ages. At the same time, the new magnetic fields push remnants of the older cycle as far as 85 degrees poleward.

"In cycles 21 through 23, solar maximum occurred

when this rush appeared at an average latitude of 76 degrees," Altrock said. "Cycle 24 started out late and slow and may not be strong enough to create a rush to the poles, indicating we'll see a very weak solar maximum in 2013, if at all. If the rush to the poles fails to complete, this creates a tremendous dilemma for the theorists, as it would mean that Cycle 23's magnetic field will not completely disappear from the polar regions (the rush to the poles accomplishes this feat). No one knows what the Sun will do in that case."

All three of these lines of research to point to the familiar sunspot cycle shutting down for a while.

"If we are right," Hill concluded, "this could be the last solar maximum we'll see for a few decades. That would affect everything from space exploration to Earth's climate."

Provided by National Solar Observatory

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