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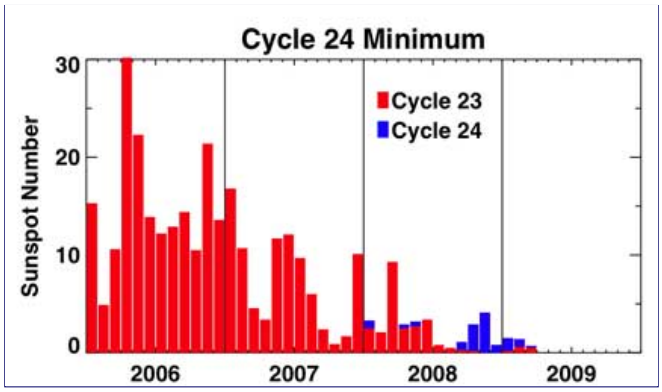
Long Minimums Usually Mean Weaker Maximums, But Sun Could Still Have Big X-Flares in 2011 to 2012

"If this solar minimum keeps going past thirteen years, we've only had one cycle before that lasted nearly fourteen years. That was about the time of our American revolution! Solar cycle 4 started in 1785, and went from then to almost 1800." - David Hathaway, Ph.D., Heliophysics Team Leader, NASA Marshall Space Flight Center

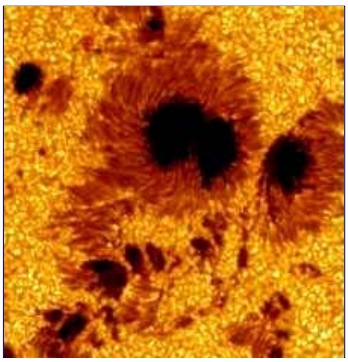
Spotless sun on May 1, 2009. Out of 365 days in 2008, 266 were without sunspots. So far in 2009, January had 25 sunspot free days; February had 23 sun spot free days; March had 28 sun spot free days and April was generally spotless . Image source: SOHO.

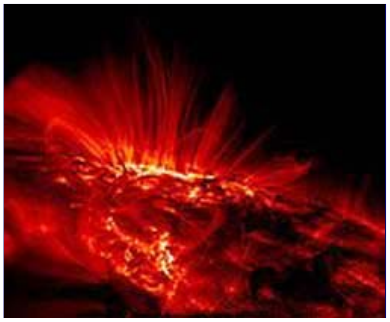


The last Solar Cycle 23 minimum began in May 1996. The next Solar Cycle 24 was expected to start some time in 2007 with a new crop of sunspots. But it is now April 2009, and this has been the most spotless sun in a century. Graphic by David Hathaway, NASA.

May 2, 2009 Huntsville, Alabama - A sunspot is a region of intense magnetic activity on the Sun's surface that are cooler than the rest of the sun. That's why they appear as dark spots. Sunspots are at temperatures of roughly 4,000 to 4,500 Kelvin, which is 6,740 to 7,640 degrees Fahrenheit, and are surrounded by hotter solar material around 5,800 Kelvin, or 9,980 degrees Fahrenheit.

Many sunspots on the sun,
March 29, 2001. Image by SOHO.





Left: July 15, 2002, "the most detailed images ever of sunspots" on sun's granular surface by solar telescope in La Palma, Canary Islands, off African coast. Resolution is 62 miles (100 km). Colorized image by Royal Swedish Academy of Sciences Institute for Solar Physics.
Right: Sunspot viewed close-up in ultraviolet light by the TRACE spacecraft.

Sun's Core = 17,999,540.3 degrees F. (10 million degrees Kelvin)

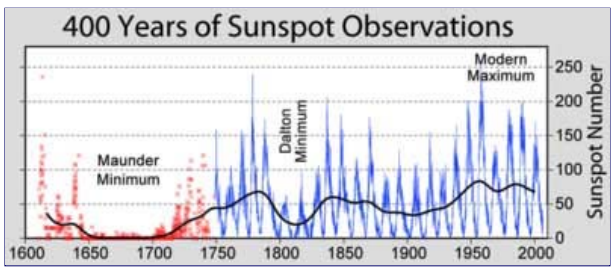
Sun's Surface = 10,340.33 degrees F. (6,000 degrees Kelvin)

Sun's Corona Above Surface = 3,599,540.33 degrees F. (2 million degrees Kelvin)

Those dark sunspots appear in cycles of about eleven years. In between spots on the sun are quiet times called solar minimums. The last solar cycle minimum 23 began in May 1996. The next solar cycle 24 was expected to start some time in 2007 with a new crop of sunspots. But it is now April 2009, and this has been the most spotless sun in a century.

Scientists did not start numbering solar cycles until 1755, after a mini-ice age in Europe that was linked to a nearly spotless sun for seventy years, a period referred to as the Maunder Minimum.

Maunder Minimum of 1645 - 1715

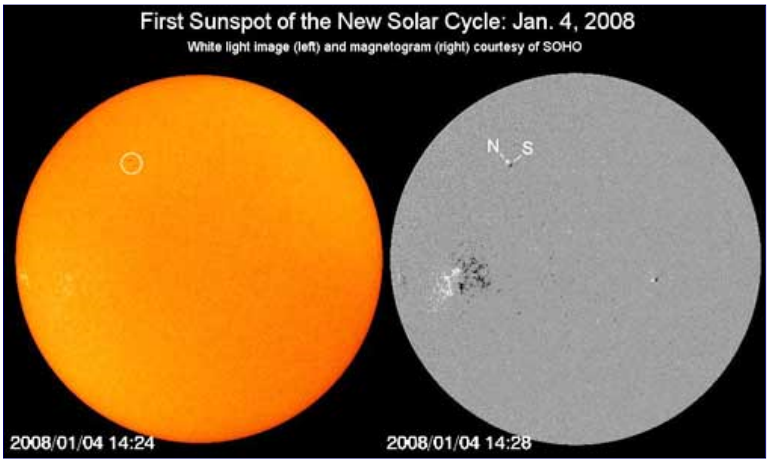


Sunspots were at the lowest number for longest time of seventy years between 1645 and 1715, in what was called the Maunder Minimum after solar astronomer Edward Maunder. During one 30-year-period within the Maunder Minimum, astronomers saw only about 50 sunspots compared to modern sunspot cycles of 40,000 to 50,000 sunspots in a 30-year-period. Source of data: Solar Influences Data Analysis Center (SIDC) at the Royal Observatory of Belgium.

The Maunder Minimum, named after solar physicist Edward Maunder, was a 70-year-long period roughly from 1645 to 1715, when sunspots became exceedingly rare. During one 30-year period within the Maunder Minimum, astronomers observed only about 50 sunspots compared to 40,000 to 50,000 sunspots in modern times.

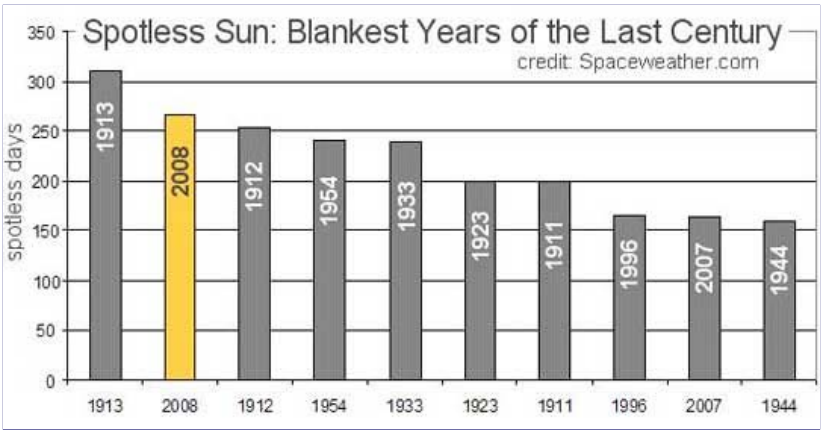
Solar Cycle 24

On January 4, 2008, a patch of magnetism on the sun was declared by NASA to be the first official sunspot of the new Solar Cycle 24. The spot was in a high-latitude on the sun with reversed polarity from the previous Solar Cycle 23.



On January 4, 2008 , this new high-latitude active solar region was magnetically reversed from sunspot magnetic directions in the previous Solar Cycle 23. So, this sunspot officially marked the beginning of Solar Cycle 24. Images courtesy SOHO/NASA/ESA.

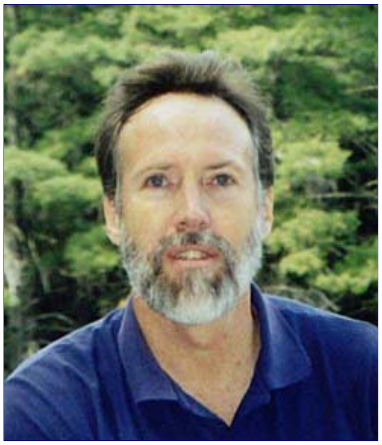
With that discovery, solar scientists expected 2008 would bring more sunspots as the new solar cycle developed intensity toward solar maximum in 2011 to 2012. But out of 365 days in 2008, 266 were without sunspots. So far in 2009, January had 25 sunspot free days; February had 23 sun spot free days; and March had 28 sun spot free days. Solar Cycle 23 began in a May 1996 minimum, so by April 2009, it's been thirteen years between minimums and still no increasing sunspots. The last time a solar cycle has gone nearly thirteen years between minimums was Solar Cycle 14 from February 1902 to August 1913, 12.5 years.



NASA reports that in 2008 (yellow in above graph), no sunspots were observed for 266 of the year's 365 days (73% of the time) - the most blank sun since 1913 when there were 311 spotless solar days (85%). Image credit: Spaceweather.com.

Recently I talked about the unusually quiet sun with David Hathaway, Ph.D., and Heliophysics Team Leader at NASA's Marshall Space Flight Center in Huntsville, Alabama. I asked him if the solar maximum of 2011-2012 could still be strong after a long minimum? I also wondered if this current solar minimum is close to going even longer than the one a hundred years ago?

Interview:



David Hathaway, Ph.D., Heliophysics Team Leader, NASA's Marshall Space Flight Center, Huntsville, Alabama: "This solar minimum has gone on far longer than I'm comfortable with! (laughs)

I take September of 1996 as the previous minimum. So, we're approaching 13 years, which is considerably longer than the average, which is just about 11 years.

THIS WOULD BE LONGER THAN THE 1901 TO 1913 CYCLE – WHICH I THINK, WAS THAT ABOUT 12 TO 12.5 YEARS?

Yeah!

The Last 14-Year-Minimum Was 1785 to 1800

IF WE GET TO JANUARY 2010 AND THE SUN STILL HAS A BLANK FACE, WHAT WOULD BE THE NEXT COMPARISON IN MINIMA IF WE START GOING INTO FOURTEEN YEARS?

If this solar minimum keeps going past thirteen years, we've only had one cycle before that lasted nearly fourteen years. That was about the time of our American revolution! Solar cycle 4 started in 1785, and went from then to almost 1800.

THE BOTTOM LINE IS: IF 2009 CONTINUES TO BE QUIET ON THE SUN, WE HAVE TO STOP COMPARING IT TO 1913 AND WE HAVE TO GO BACK TO THE 1700S.

Yes. A typical sunspot length is about eleven years, but there is a variation of about fourteen months around that. So, 66% of all the sunspot cycles are between ten and twelve years long. So, once you start getting longer than 12 years, you're getting down into the minority of sunspot cycles. If you get up to fourteen years, it's truly exceptional.

AS WE ARE IN 2009, SOLAR PHYSICISTS TODAY STILL DO NOT KNOW WHY THE SUN WOULD GO INTO SUCH A LONG QUIET PERIOD?

I don't think we can honestly say that we know what caused the Maunder Minimum and what causes these Grand Minima. There is little doubt that it has something to do with the flows within the sun and the strengths of the magnetic fields and their configuration within the sun. But exactly what it is that does it, no, we don't know.

DO YOU HAVE A BET ON WITH ANYBODY ABOUT WHEN SUNSPOTS MIGHT EMERGE ON THE SUN AGAIN?

Ah, I already lost that bet! (laughs) I lost that bet two years ago! Again, back in 2006, I thought using the computer model technique of geomagnetic activity at that time and expecting we were near minimum, I thought it was going to be a really big cycle that fit right in with us being near minimum and having a short cycle. And so we had a bet on about when the first sunspot of the new cycle would come out. It didn't come until January of 2008! So, yeah, I had to throw a party for everyone in my solar group! (laughs)

BEYOND LOSING THAT BET, WHAT DOES YOUR INTUITIVE SENSE HAVE ABOUT WHEN WE MIGHT START SEEING SUNSPOTS?

Well, we did start seeing sunspots again last fall (2008). The thing that bothers me is that it stopped! Last fall – in fact, I went to a meeting in December 2008 and I thought, 'This is

great!' The new cycle finally started and it looks like August 2008 was minimum. We saw September, October, November and the number of sunspots were rising and they were all new cycle sunspots. We were finally on our way. But I should have kept my mouth shut because in December, Bam! It stopped! So, for December 2008, January 2009, February, March and now April - where did it go? (laughs) Why did it stop? It ought to start producing more and more sunspots here. I think the average last month (March 2009) was .7 or 1.5. But we ought to be seeing ten sunspots on an average day.

We ought to be seeing something almost every day on the sun, but we go days and days, we go weeks! Without anything on the sun!!

Why Is the Sun So Quiet?

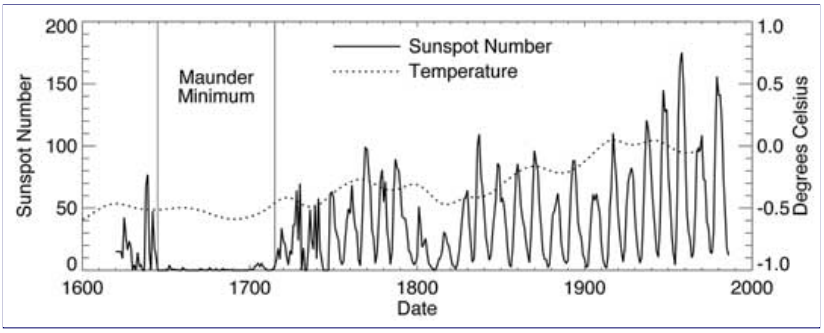
WHAT IS THE CURRENT SOLAR ASTROPHYSICS THINKING ABOUT WHY THIS IS HAPPENING?

There's been grumbling within the community about the possibility that we're headed into what we call a Grand Minimum. The sunspot cycle goes through a minimum about every eleven years, but we've seen one very extensive period we call the Maunder Minimum from 1635 to 1715. Between those years, 70 years, basically the sun did not have any sunspots for 70 years.

If Sun Goes Into Another Maunder Minimum, What Would Happen to Earth's Climate?

IF WE WERE MOVING INTO ANOTHER MAUNDER MINIMUM TYPE EVENT OF NO SUNSPOTS FOR ANOTHER 70 YEARS, WHAT MIGHT HAPPEN IN THE CLIMATE NOW, GIVEN THE BLANKET OF CO2 AROUND THE EARTH?

Most indications now are that greenhouse gases, CO2 in particular, play a much bigger role now in Earth's climate than the sun does. Most of my colleagues that are involved with this research would agree with me when I say that even if the sun does go into a Grand Minimum, that's not going to offset the warming that is coming from the greenhouse gases. So, I don't think we can look at solar activity or a Grand Minimum to save us from the increases we've seen over the last 50 to 100 years.



Temperatures on Earth have continued to rise since 1800 in spite of the up and down cycles in numbers of sunspots. Graph by David Hathaway, NASA.

SO, IRONICALLY, THE FACT THAT WE HAVE AN INCREASED CO2 BLANKET FROM INDUSTRIAL RELEASES OF CO2 AND OTHER GREENHOUSE GASES WOULD KEEP THE EARTH WARMER IF THE SUN DOES GO INTO ANOTHER MAUNDER MINIMUM?

Yes. My expectation from the links I see between solar activity and climate suggests that if we go into a Grand Minimum, it might slow the Earth's increase in temperature, but it's not going to make it go away. On the other hand, the warming due to greenhouse gases might keep us from having another Little Ice Age! (laughs)

WHICH IS IRONIC.

A bit, yes!

After Long Minimum,

Could Maximum Be Strong?

COULD THIS LONG MINIMUM EVOLVE INTO A REALLY BIG MAXIMUM IN 2011 TO 2012?

I'm highly doubtful at this point. I really am. It might be that we're just headed for a small cycle, no Grand Minimum. Who knows? I tested a number of techniques – basically everything I could find for predicting solar activity. The best techniques we have are now indicating that this next solar max cycle should be small.

We still have some important models out there that have said it's going to be a very big cycle. I think they need to be worried (about their projection) myself!

I did project back in 2006 that I thought this would be as big as the last two or three solar cycles. But at this point, all the indicators that have worked for us in the past are now indicating that this cycle ought to be small. One of the indicators, although it is not a strong one, is how long has the last cycle been. Usually the longer the cycle, it is followed by a small cycle and usually low minima are followed by small cycles – not always, but usually.

But more importantly, geomagnetic activity late in a cycle is usually associated with the size of the next cycle. That is low this time. The strength of the sun's polar fields that we think feed into the sun's next sunspot cycle or the one thereafter – those were HALF what they had been for the past three or four cycles. That also suggests this is going to be a small cycle. So, I think everything is suggesting a small cycle rather than a big one. And at this point, I would be really surprised if we end up with a cycle much bigger than average for peaking in the time frame of 2012 to 2013.

Weak Solar Cycle 24 Is Good for Satellites, Airplanes and Power Stations

WHICH WILL HELP OUR SATELLITES ORBITING EARTH AND AIRLINERS, RIGHT?

Yes. In fact, there are other astronomers on this floor who are involved with the Chandra X-Ray observatory and they keep coming to me and patting me on my back as if I'm responsible for this quiet sun. (laughing), thanking me for how inactive the sun is. Their satellites live longer with less solar activity, particularly on Chandra. Their detector is prone to damage from solar energetic particles and so they are very pleased with this spotless sun.

I'm sure satellite operators – their satellites stay in orbit longer. We were worried about servicing the Hubble mission and re-boosting it, afraid that if this Cycle 24 started off and got big, we might not get to it to get it high enough to survive for awhile. But it looks like Hubble is in good shape at this time, so yeah! people who fly satellites are quite pleased with this inactive sun. But most of us solar astronomers are really upset about it! (laughs)

BECAUSE YOU WANTED TO SEE ANOTHER STORMY SUN?

Ah, the sun is boring without activity, you know?! (laughs) If you don't have nice, big sunspots up there blasting material off of the sun, it's just kind of boring.

BUT IF WE GO INTO A MAUNDER MINIMUM FOR 70 YEARS, YOU GUYS MIGHT BE BORED, BUT OUR SATELLITES, AIRLINES AND POWER STATIONS WILL GET ALONG A LOT BETTER.

Certainly they will and I'm joking a little bit about the boredom. Certainly, if we do go into a Grand Minimum, then the interesting thing is why? What exactly happened inside the sun that did this? And now, we've had all the tools up there for the last 30 to 50 years that we ought to be able to get a handle on this. In particular, we've had the new science of helio-seismology where we can probe the inside of the sun and see how the flows were changing inside the sun. We ought to have a good handle on the state of the sun now and what's happening inside the sun and on its surface that reflects the activity.

But the weak fields this time around, explaining that is more difficult. It seems like we're missing something here, so it will be interesting to find out what it is.

SO YOU ARE GENUINELY BAFFLED?

I think that would be true, yeah! I am! I'm baffled! It means I've got a lot of work left to do to understand this beast! (laughs)

Still Could Get Big X-Class Flares in 2011 to 2012

DOES THAT MEAN THERE WON'T BE ANY X-40 FLARES LIKE THERE WAS IN CYCLE 23?

Ah, you can't bet on that! All it takes is one angry sunspot to make a big flare like that. The more sunspots you have, the more likely you are to get a big, twisted up sunspot. But, it can happen! It's interesting that if you look at the record of solar flares, I think for the last three solar cycles, the minimums were punctuated by an X-class flare!

Having few sunspots does not preclude the possibility of still having a big flare. It just lowers the probability of that.

DEPENDING UPON THE ANGLE OF THAT FLARE TO THE EARTH, WE STILL COULD END UP WITH TROUBLE FOR SATELLITES AND AIRLINES AND POWER STATIONS EVEN IN A QUIETER MAXIMUM?

Yes. Again, those are all possibilities. It really comes down to the numbers. The more sunspots on the sun, the more likely you are to have flares and coronal mass ejections and energetic particles that cause all these ill effects on our technologies. It can still happen in a small cycle. The big question is: Can it happen without any sunspots at all? For the most part, you really need sunspots, you really need those strong magnetic fields on the sun to do this.

I'm anxious to see more! I'm getting really tired of waking up in the morning, going to the web and seeing what there is on the sun and finding out there is nothing there!

THERE IS NO REASON FOR PEOPLE TO BE ALARMED?

No. There's been a lot said about the Winter Solstice in the year 2012, and I guess it's because the Mayan calendar ends then. And I think that's a problem for the people who made the Mayan calendar. I'm not at all worried about it. That day will come and go and we can rise the next morning to see the sun rise yet again.

EITHER WITH OR WITHOUT SUNSPOTS!

Either with or without spots, there you go! (laughs) Hopefully, it will have a lot by then!"

More Information:

For more information about the sun and solar cycles, please see Earthfiles reports in the **Earthfiles Archive**:

- 04/07/2009 — Longest Solar Minimum Since 1913
- 09/23/2008 — Solar Wind Pressure Lowest in 50 Years
- 08/29/2008 — Still No Sunspot Action on the Sun
- 01/10/2008 — Solar Cycle 24 Has Begun
- 01/13/2007 — Confusing Sun: Will Solar Cycle 24 Be Most Intense On Record?
- 08/23/2006 — Solar Cycle 24 - Headed for Intense X Flares by 2010-2012?
- 03/17/2006 — Planet Earth's Ice Melt
- 11/18/2005 — Is the Sun Heating Up?
- 09/29/2005 — 2005 Arctic Summer Ice Melt - Largest On Record
- 09/23/2005 — 9 X-Class Solar Flares Between September 7 - 19, 2005.
- 05/07/2005 — Did Milky Way Gas and Dust Turn Earth Into Icy Snowball Four Times?
- 02/11/2005 — Sunspot Region 720 Emitted Strongest Solar Radiation Since October 1989.
- 10/29/2003 — Fifth Intense Solar X-Flare - What's Happening On the Sun?
- 07/16/2003 — First 3-D Images of the Sun's Granular Surface
- 10/25/1999 — A Blast of Solar Wind Provokes Aurora Over Northern U. S.

Websites:

NASA Solar Cycle Prediction: **http://solarscience.msfc.nasa.gov/predict.shtml**

NASA Solar Physics: **http://solarscience.msfc.nasa.gov/**

Solar and Heliospheric Observatory (SOHO): **http://sohowww.nascom.nasa.gov/**

Space Weather: **http://www.spaceweather.com/**

Sunspots: **http://en.wikipedia.org/wiki/Sunspot**

3-D Surface of the Sun: **http://www.lmsal.com/Press/SPD2003.html**

High Altitude Observatory (HAO): **http://www.hao.ucar.edu/**

National Center for Atmospheric Research (NCAR): **http://www.ncar.ucar.edu/**

Ulysses Solar Mission: **http://www.esa.int/esaSC/120395_index_0_m.html**

Max Planck Earth Science and Climate Research: **http://www.mpg.de/english/researchFields/CPT/GEO/index.html**

NASA TRACE Coronal Explorer: **http://sunland.gsfc.nasa.gov/smex/trace/**

Solar Influences Data Analysis Center (SIDC): **http://sidc.oma.be/**

Maunder Minimum 1645 - 1715: **http://en.wikipedia.org/wiki/Maunder_minimum**

Dalton Minimum: **http://en.wikipedia.org/wiki/Dalton_Minimum**

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