Studies Show Weakening Sun, Possible New Ice Age

by Laurence Hecht

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Three independent U.S. studies of solar activity arrive at the same conclusions put forth earlier by the Pulkovo Observatory in St. Petersburg, Russia:

- solar activity is declining;
- the current solar cycle, 24, which began in December 2009, is likely to be a weak one; and
- the following cycle, beginning around 2018 to 2020, may be so weak as to bring on a new Little Ice Age.

In the worst case, the developments could signal the beginning of a new period of reduced solar activity and extremely cold climate, like that in the period known to solar scientists as the Maunder Minimum, also known as the Little Ice Age, which lasted from approximately 1645 to 1715. Such has been the expectation of the Russian group led by Habibullo Abdussamatov of the Pulkovo Observatory, a possibility that is now being

In the words of the National Solar Observatory report on weakening solar activity: "An immediate question is whether this slowdown presages a second Maunder Minimum, a 70-year period with virtually no sunspots between 1645 and 1715." An earlier period, 1550-1650, also saw extremely cold Winters, as shown in this painting (1608) by the Dutch artist Hendrick Avercamp (1585-1634).

openly mooted by some of his American counterparts. To meet such an eventuality, a rapid mobilization of high technology capabilities, especially the energy-dense technologies of nuclear fission and fusion, is imperative for the survival of civilization.

The three new studies were announced in a press conference this week at the annual meeting of the Solar Physics Division of the American Astronomical Society in New Mexico, and summarized in an online report in *Astronomy* magazine attributed to the National Solar Observatory.

How the Sun Is Changing

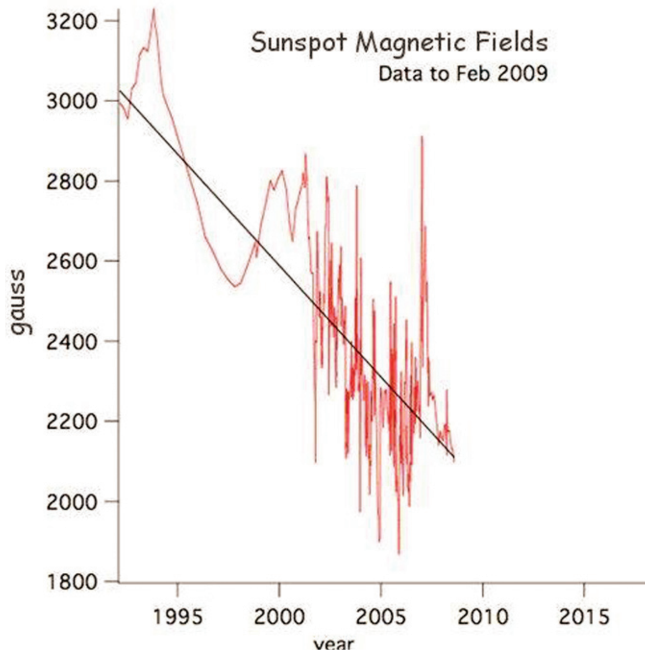
In one of the papers, Matthew Penn and William Livingston of the National Solar Observatory, examine the continuing decline in the magnetic field strength of sunspots (**Figure 1**), and predict that by the next 11-year solar cycle, magnetic fields erupting on the Sun will be so weak that few if any sunspots will be formed. The magnetic strength of a sunspot is determined by observing the changes, known as Zeeman splitting, of the spectral line of iron produced on the Sun. The distance between the split spectral lines is proportional to the magnetic field strength.

In 2006, the authors first reported a decline in field strength of sunspots which was independent of the normal sunspot cycle. Those measurements also revealed a threshold value of the magnetic field strength of about 1,500 gauss, below which, the dark spots on the face of the Sun are not observed. (The gauss is the unit of magnetic strength, roughly equal to that found in 1832, when Carl Gauss and Wilhelm Weber first measured the absolute value of the horizontal intensity of the Earth's magnetic force.) Followup papers by Penn and Livingston[1] generated a great deal of controversy by their implicit challenge to the global warming thesis.

In their new study, Penn and Livingston observe a decline in the magnetic strength of sunspots of about 50 gauss per year during Solar Cycle 23 (1996-2008) and continuing into Cycle 24, which began in December 2008. Extrapolating the trend leads to a disappearance of sunspot activity by some time around the end of the present decade. The study is based on examination of more than 13 years of data collected by the NSO's 62-inch McMath-Pierce Solar Telescope at Kitt Peak, Arizona,

1. For example, Matthew J. Penn and William Livingston, "Long-term Evolution of Sunspot Magnetic Fields." http://www. probeinternational.org/Livingston-penn-2010.pdf

FIGURE 1



Livingston & Penn, *Eos,* July 2009

The maximum sunspot field strength is plotted versus time, during the period from 1992 to February 2009; a 12-point running mean is shown, and a linear fit to the data is plotted. Apart from a few measurements, the linear trend has been seen to continue throughout this solar minimum.

A very different sort of study, using data from the Global Oscillation Network Group (GONG), leads to similar conclusions about a declining Sun. GONG consists of six observing stations around the world which examine surface pulsations, similar to the seismic waves of earthquakes, caused by sound reverberating through the Sun. The 15-year-old group discovered the relationship of a phenomenon known as the solar torsional oscillation to the solar cycle. The oscillation is an east-west (zonal) flow of wind inside the gaseous Sun, which shows a regular change in latitude. The latitude at which the wind stream is found, presages the latitude of new spot formation in each cycle, and successfully predicted the delayed onset of the present Solar Cycle 24.

As cited in *Astronomy* magazine, Frank Hill, lead author of the paper presented by the GONG group, explains:

"We expected to see the start of the zonal flow for Cycle 25 by now, 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."

A third study, led by Richard Altrock, manager of the Air Force coronal research program, also indicates anomalous activity in the Sun.

Using four decades of observations with the National Solar Observatory's 16-inch telescope at Sunspot, N.M., Altrock observed a slowing of the usual poleward movement of magnetic activity in the Sun's corona. A new solar cycle is characterized by the appearance of sunspots at high latitudes in both hemispheres. These gradually move towards the solar equator over the course of the cycle. At the same time, remnants of the magnetic field lines from the old cycle are pushed upward to the poles, in a phenomenon called "the rush to the poles." The ionized iron carried by the magnetism can be detected with a sensitive photometer.

This time, the rush to the poles is not occurring. According to Altrock, as cited in *Astronomy* magazine:

"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."

The earth is no longer threatened by the catastrophic global warming forecast by some scientists; warming passed its peak in 1998-2005. . . . Consequently, we should fear a deep temperature drop, but not catastrophic global warming. Humanity must survive the serious economic, social, demographic and political consequences of a global temperature drop, which will directly affect the national interests of almost all countries and more than 80% of the population of the Earth.

—Habibullo Abdussamatov (2008)

Threat of New Ice Age

In the words of the National Solar Observatory report: "An immediate question is whether this slowdown presages a second Maunder Minimum, a 70-year period with virtually no sunspots between 1645 and 1715." As established by American astronomer John Eddy, that period coincided with a sharp drop in temperature, now known as the "Little Ice Age."[2]

The serious threat of a decline in solar activity bringing on a new Little Ice Age had been raised earlier by Russian solar astronomer Habibullo Abdussamatov, director of the Space Research Laboratory of the Pulkovo Observatory in St. Petersburg. The work of Abdussamatov constitutes a fourth line of evidence that the Sun may be going into decline, and the climate into a profound cooling phase.

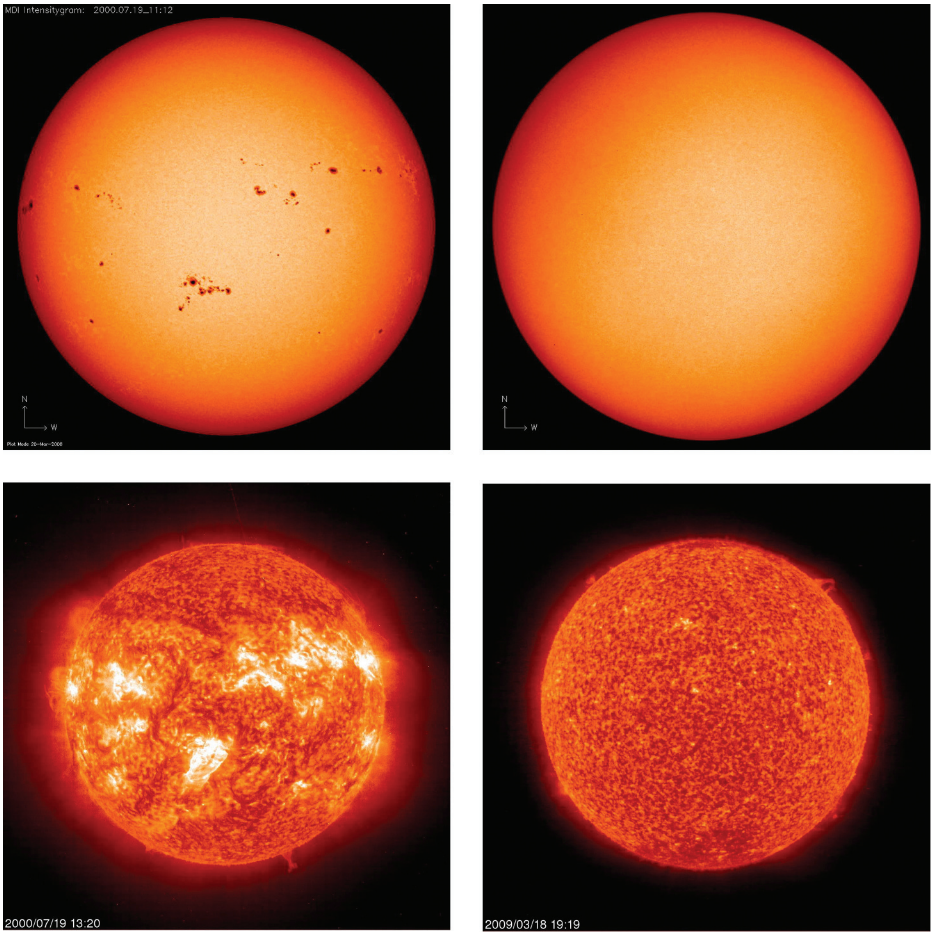
Among the ominous warning signs, Abdussamatov has pointed to the work of the St. Petersburg geophysicist Eugen Borisenkov, who showed in 1988, that solar minima of the Maunder type follow an approximately 200-year cycle, and have done so through 18 documentable epochs of deep minima for the past 7,500 years. In a 2004 paper,[3] Abdussamatov shows that a change in size of the solar radius follows the change in the Total Solar Irradiance (TSI) through the 11-year solar cycle. He cites the work of M.L. Sveshnikov, showing that the amplitude of the radius variations declines during periods of reduced solar activity. Abdussamatov has also noted the variation in the amplitude of changes in the TSI, from 1978 to 2008, showing an accelerating decline from Solar Cycle 21

2. A continual record of sunspot observations dates back to 1611, when Johann Goldsmid (Fabricius) in Holland, Christopher Scheiner in Germany, Thomas Harriot in England, and Galileo Galilei in Italy, all reported observations. In 1630, Scheiner published a compilation of two decades of observations, and astronomers throughout Europe continued daily observations. But from approximately 1645-1715, the level of sunspot activity declined drastically. The decline became known as the Maunder Minimum after the 19th-Century English astronomer who made a study of the latitude of sunspots and the magnetic cycle of the Sun.

A 1976 study by American astronomer John A. Eddy dispelled any doubts that the decline may have been due to a lack of observations. By examining carbon-14 tree ring data and other proxies for solar activity, Eddy showed that the decline was real, and coincided with an interval of extremely cold climate, also recorded in literature and art, such as in paintings of ice skating on the Thames.

3. Habibullo I. Abdussamatov, "About the long-term coordinated variations of the activity, radius, total irradiance of the Sun and the Earth's climate," Multi-Wavelength Investigations of Solar Activity, *Proceedings IAU Symposium,* No. 223 (2004) http://www. gao. spb. ru/english/astrometr/Symp_223. pdf

FIGURE 2



NASA

These images from the Solar and Heliospheric Observatory (SOHO) spacecraft compare sunspots on the Sun's surface (top row) and ultraviolet light radiating from the solar atmosphere (bottom row) at the last solar maximum (2000, left column) and at the current solar minimum (2009, right column.) The sunspot images were captured by the Michelson Doppler Imager (MDI) using filtered visible light. On March 18, 2009, the face of the Sun was spotless.

(1976-86) to the present. These changes in solar radius and TSI, he supposes to be indicators of the energetic activity of the Sun's core, the Sun being a variable star.

In a 2006 paper,[4] Abdussamatov had already forecast a delayed onset and reduced activity for the present Solar Cycle 24 (**Figure 2**). There, Abdussamatov proposed that the duration of the short-term solar cycle, which has varied from 9 to 13.4 years, is determined by a parent, or secular, cycle of longer duration. Our understanding of the precise nature of the parent cycle is limited by the small number of reliably studied cycles (there have been only 13 such cycles). However, a trend of rise, maximum, and descent of the secular cycle could be noted in the periods from 1755 to 1810, 1810 to 1913, and 1913 to 2006, the year of publication. The 11-year cycles at the descending phase of the secular cycle showed a tendency to be longer than the cycles at the rising and maximum phases. On this basis, he had forecast a prolonged Cycle 23 lasting to July 2007. The cycle was prolonged, but by more than Abdussamatov had expected, not ending until December 2008.

In a 2008 paper,[5] Abdussamatov forecast severely reduced activity in Cycles 25 and 26:

"The earth is no longer threatened by the catastrophic global warming forecast by some scientists; warming passed its peak in 1998-2005, while the value of the TSI by July-September of last year had already declined by 0.47 watts per square meter," Abdussamatov wrote. "Consequently, we should fear a deep temperature drop, but not catastrophic global warming. Humanity must survive the serious economic, social, demographic and political consequences of a global temperature drop, which will directly affect the national interests of almost all countries and more than 80% of the population of the Earth."

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4. Kh. I. Abdussamatov, "The Time of the End of the Current Solar Cycle and the Relationship between Duration of 11-Year Cycles and Secular Cycle Phase," *Kinematics and Physics of Celestial Bodies*, Vol. 22, No. 3, pp. 141-143 (2006). http://www. gao.spb.ru/english/astrometr/KPhCB22_3_141. pdf

5. Habibullo Abdussamatov, "The Sun Defines the Climate," *Nauka i Zhizn*, No. 1, pp. 34-42 (2009), transl. from Russian by Lucy Hancock. http://www. gao. spb. ru/english/astrometr/abduss_nkj_2009. pdf

How Solar and Cosmic Activity Change Climate

The means by which a decline in solar activity causes severe cooling is now partially, but not yet completely, understood. The variation in the total energy output of the Sun comes to only about 0.1% of the Total Solar Irradiance, not enough to cause drastic heating or cooling by purely thermal means. However the links between the Sun and climate turn out to be more subtle and interesting.

As one example, the work of Danish atmospheric physicist Henrik Svensmark and his collaborators has shown that the secondary particles, produced when galactic cosmic rays collide with atmospheric gases, serve as condensation nuclei for the formation of low-level clouds, which, in turn, cool the Earth. The connection to solar activity is as follows.

American physicist Scott Forbush[6] had discovered in the 1930s that the flux of galactic cosmic rays (charged particles, mostly hydrogen nuclei, coming from beyond our galaxy) was reduced during geomagnetic storms. In 1958, one of the early satellites developed by James Van Allen, first showed us the role of the Sun's charged particle output, known as the solar wind, in creating magnetic storms on Earth. (Prior to that, it was thought that geomagnetic storms originated in the Störmer current ring, about six Earth radii out into space.) Further work showed that the solar wind formed a sort of magnetic shield around the Solar System, known as the heliosphere. When the solar wind is stronger, more of the cosmic rays are deflected from striking Earth. In periods of reduced solar activity, more cosmic rays strike the Earth's atmosphere, producing the secondary particles which can help to form low-level clouds.

Another example of the interaction between solar activity and Earth's weather is known as the Wilcox effect. In 1974, John M. Wilcox and colleagues proposed that vorticity in the upper atmosphere, including that which might produce severe storms and hurricanes, was controlled by what is called magnetic sector boundary crossings. As the Sun spins on its 27-day rotation, the magnetic field of the solar wind takes on the rippled shape of a ballerina's tutu. As a result of the asymmetry between the Sun's rotational and magnetic axes, the North and South magnetic polarity of the solar wind can fall sometimes above, and sometimes below, the plane of the Earth's orbit. On a short-term but irregular period varying from less than a week to several weeks, the Earth crosses the sector boundary between North and South polarity. Wilcox et al.[7] showed that changes in the atmospheric vorticity were influenced by these sector boundary crossings.

More recently, P. Prikryl and his colleagues[8] have revisited the Wilcox effect, showing that the magnetic sector boundary crossings influenced the onset of severe extratropical storms in the Atlantic and Pacific.

Many other important interactions among the Sun, the galaxy, and meteorological and geophysical events on Earth remain unknown or still uninvestigated. The latest news from the Sun serves as a reminder that we ignore such investigation at our own peril.

6. James A. Van Allen, "Scott Ellsworth Forbush, 1904-1984: A Biographical Memoir" (Washington, D.C.: National Academies Press, 1998). http://www. nap. edu/html/biomems/sforbush. pdf

7. John M. Wilcox et al., "Influence of Solar Magnetic Sector Structure on Terrestrial Atmospheric Vorticity," *Journal of the Atmospheric Sciences*, Vol. 31, pp. 581-588 (March 1974).

8. P. Prikryl, V. Rusin, and M. Rybansky, "The influence of solar wind on extratropical cyclones—Part 1: Wilcox effect revisited," *Annales Geophysicae*, Vol. 27, pp. 1-30 (2009). http://www.ann-geophys.net /27/1/2009/angeo-27-1-2009. pdf