The Sun is Changing States: Time to Reassess Where It May be Heading!

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We are at the verge of entering solar cycle 24. It is interesting to watch this solar cycle unfold. Recently Rachel Howe and Frank Hill of the National Solar Observatory from their studies of the solar jet stream, which is actually a plasma current called a torsional oscillation, indicate the sun is about to wake up from a rather long magnetic slumber. Time will tell. As of the end of June, the cumulative number of spotless days (days without sunspots) in this transition into solar cycle 24 stands at 651. As this solar minimum comes to an end, the number of spotless days per month will quickly tapper off.

The transitions into Solar Cycles (SC16-23), referred to as "recent solar cycles" (years 1923 to ~2008), averaged 362 cumulative spotless days. Those minimums ranged from 227 - 568 spotless days. Since the current transition now exceeds 568 spotless days, it is fairly clear that the sun has undergone a state change. The solar Grand Maxima state that has persisted during most of the 20th century has come to an abrupt end. The "old solar cycles" (SC 10-15, years 1856 to 1923) averaged 797 spotless days, over twice that of the "recent solar cycles". Those solar minimums ranged from 406 - 1028 spotless days. If this solar minimum ends soon then the upcoming solar cycle may be similar to the “old solar cycles”.

An increase in the number of cumulative spotless days during a solar minimum appears to correlates to a reduction in the number of sunspots over the entire solar cycle. The "old solar cycles" produced overall 38% fewer International Sunspot Numbers than the "recent solar cycles". This might lead one to erroneously conclude that solar storms will diminish in intensity during the upcoming solar cycle. But historically observations show the exact opposite. The “old solar cycles” produced far more intense solar storms than the “recent solar cycles”.

In terms of spotless days, there are two numbers to watch. These are 654 and 736. The range between these two numbers may represent a “sweet spot” for enhanced solar storm activity.

The solar minimum preceding Solar Cycle 10 had 654 spotless days. The largest known solar storm in modern history occurred during Solar Cycle 10. On 1 September 1859, an extremely rare white light flare occurred on the surface of the sun. This event was referred to as the Carrington flare. Minutes later a burst of high energy protons struck earth. This Solar Proton Event (SPE) was the strongest observed in 450 years producing an omni-directional fluence of 18.8 billion solar protons (with energies greater than 30 MeV) per square centimeter. Seventeen hours and forty minutes later the main mass of the Coronal Mass Ejection (CME) struck the earth like a large battering ram distorting the earth’s magnetic field producing a massive geomagnetic storm. The intensity of this storm is estimated as magnetic intensity Disturbance Storm Time (Dst)

of 1,760 nT (nano-Teslas). By comparison, the strongest geomagnetic storm since 1957 occurred on 13 March 1989 with a Dst of 589 nT.

If a geomagnetic storm with the magnitude of the solar storm of 1859 were to occur today, the effect on our modern technologically dependent society would be extremely grave. Of these, the greatest threat would lie in the loss of stable electrical power.

A massive solar storm could induce a major electrical blackout. Actually that would be an understatement. Perhaps the term “Mother of all Blackouts” might come closer to fitting the mark. A recent report by the National Academy of Science titled “Severe Space Weather Events” indicates a massive solar storm could damage approximately 365 Extra High Voltage (EHV) power transformer in the United States causing a blackout affecting around 130 million people. Many EHV transformers are large, the size of a small house, and very unique. They are not off-the-shelf items. They are costly (around $10 million each) and have a manufacture lead-time of a year or more for replacement. As a result, restoration would be slow and the massive blackout could extent through many months.

The solar cycle with the next highest number of cumulative spotless days was Solar Cycle 13 with 736 spotless days. Five very large SPE’s occurred in Solar Cycle 13. These SPEs produced solar proton fluence of 2.3 billion, 7.7 billion, 11.1 billion, 8.0 billion and 3.1 billion respectively. The (11.1 billion) SPE was the second strongest Solar Proton Event detected in 450 years of ice core records. By way of comparison, the strongest SPE’s during the past 5 solar cycles (1954 to ~2008) had a solar proton fluence of 8.0 billion for a November 1960 event and 5.0 billion for an August 1972 event.