The Precursor Method of Predicting Solar Cycles

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In a one page feature attached to the 2006-42 e-mail issue of QRZ DX (edited and published by N4AA), I listed six predictions from the scientific community for the maximum smoothed sunspot number of Cycle 24. These predictions ranged from a low of 42 to a high of 170. I mentioned that the root cause of having so many wide-ranging predictions was due to the fact that scientists do not completely understand the processes in the Sun that make sunspot cycles.

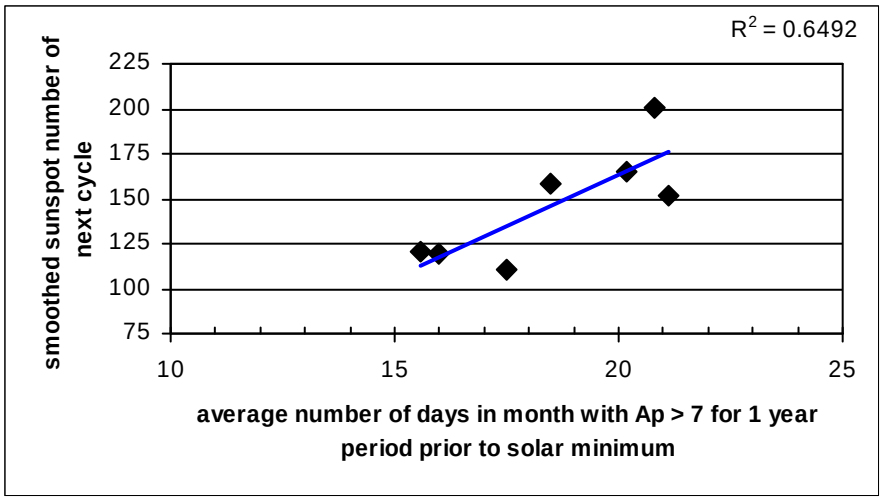
Without a complete understanding of solar cycles, various methods have been devised to predict future solar cycles. Historically, one of the better methods of predicting future solar cycles has been the precursor method. This method assumes that some parameter in the previous cycle tells what the next cycle will do. One such parameter is geomagnetic field activity. In other words, how quiet (or stormy) the Sun is as we approach solar minimum will tell us how big the next solar cycle will be.

Let's look at geomagnetic field activity for the period from one year before solar minimum to solar minimum for all solar cycles for which we have readily available geomagnetic field activity data. With daily planetary A index (Ap) data back to 1932, we can look at Cycles 17 through 23.

What we'll do is determine the number of days in each month, from twelve months before solar minimum to solar minimum, when the Ap index was greater than 7, indicating conditions other than quiet. Then we'll average the 13 months of data for each solar minimum period. The following table shows the result of this analysis.

	Minimum between Cycles 16 and 17	Minimum between Cycles 17 and 18	Minimum between Cycles 18 and 19	Minimum between Cycles 19 and 20	Minimum between Cycles 20 and 21	Minimum between Cycles 21 and 22	Minimum between Cycles 22 and 23
average number of days in month with Ap > 7	16.0	21.1	20.8	17.5	20.2	18.5	15.6

Now let's plot the average number of days in the month with Ap > 7 for each of the seven solar minimum periods against the maximum smoothed sunspot number of the corresponding next cycle. The following figure shows the result of this effort.



Note that the trend (the blue line) indicates that the stormier the period prior to solar minimum, the bigger the next solar cycle. For my crude analysis, the correlation is decent (correlation coefficient of 0.6492), but not perfect (no correlation would be $R^2 = 0$ and perfect correlation would be $R^2 = 1$). **Please understand that this analysis was simplified to demonstrate the methodology of the precursor method, not to make a rigorous prediction for Cycle 24.** A real precursor prediction would go into greater depth.

Regardless of the confidence of this crude analysis, the obvious question is "how is the approach to solar minimum between Cycle 23 and Cycle 24 going?" So far the approach to solar minimum is less stormy (more quiet) than the seven solar minimum periods in the previous table. Does this mean Cycle 24 will be small? Perhaps – remember this was a crude analysis. We'll just have to wait to see what happens.