The Correlation Between Solar Flux and Sunspot Number

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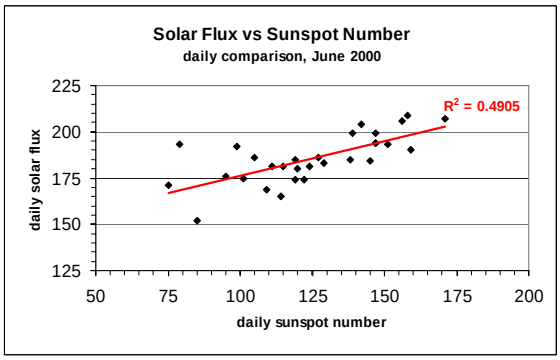
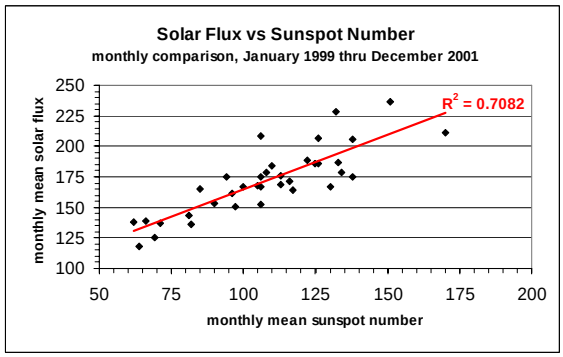
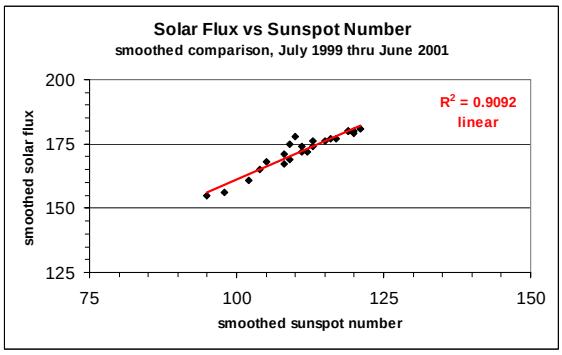
Our propagation prediction programs allow us to input either a value of the 10.7cm solar flux or a sunspot number to run predictions. That says there's a correlation between solar flux and sunspot number. What is this correlation? Is it with daily values? Or is it with something else? Let's first look at the correlation between daily values (plot on the left) and monthly mean (average) values (plot on the right).

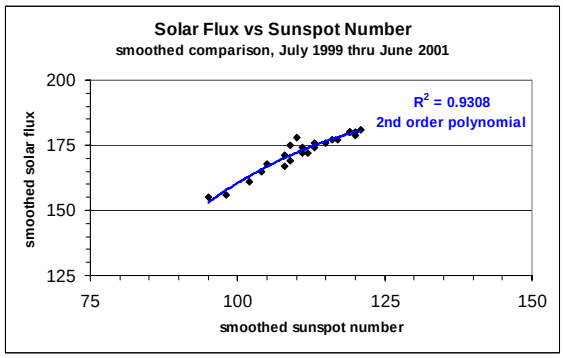




For both plots a best-fit linear trend line (in red) has been added. The red R^2 value in the upper right corner of each plot tells us how well correlated the values are. If $R^2 = 1$, this would indicate perfect correlation and all the data points would fall right on the trend line. If $R^2 = 0$, this would indicates no correlation, and the data points would be widely scattered about the trend line.

With an R^2 of 0.4905 for the daily values and an R^2 of .7082 for the monthly mean values, we conclude that the solar flux and sunspot number are somewhat correlated on a daily and monthly mean basis. But the correlation is much better using smoothed values. The following plots do this with a linear trend line in red on the left (as in the first two plots) and a second order polynomial trend line in blue on the right.





With an R^2 of .9092, the linear trend line for the smoothed values is very good. But it is even better using a second order polynomial trend line – it's up to .9308.

This correlation between smoothed solar flux and smoothed sunspot number using a second order polynomial trend line is the basis for the equations seen in our propagation literature. Using the term φ_{12} for the smoothed solar flux and the term R_{12} for the smoothed sunspot number, we have:

$$\varphi_{12} = 63.75 + 0.728\ R_{12} + 0.00089\ (R_{12})^2 \qquad \text{and} \qquad R_{12} = (93918.4 + 1117.3\ \varphi_{12})^{1/2} - 406.37$$

Note that these two equations are intended to be used with smoothed values. Using these equations to convert from daily solar flux to daily sunspot number or vice versa will result in much uncertainty.