

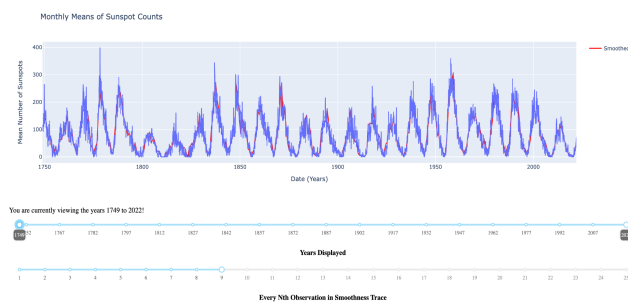
SUNDASH: MONITORING AND ANALYZING SOLAR ACTIVITY

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EXTENDED ABSTRACT

Levels of solar activity change regularly, and many aspects of human life are affected as a result. For example, when these activity levels are relatively high it can produce displays of aurora light in the sky, as well as interrupt communications from satellites. Solar activity levels have been long observed by humans and recorded as the quantity of sunspots visible at a given time since at least 1749. The Royal Observatory of Belgium houses these observations.

As with most long sets of data, not much conclusion may be drawn simply from reading over the seemingly-endless written digits and their explanations. Visualizations of data are extremely helpful with understanding the real-life applications of what the data represents. These visualizations have been created in the Royal Observatory of Belgium: Sunspot Data dashboard. Firstly, it was important to understand how the number of sunspots changes, cyclically, over time. This was best shown using a line plot representing the monthly means of each recorded month since 1749. In order to see certain ranges of years more closely, the dashboard is accompanied by a user-accessible slider to adjust the x-axis of the plot. The plot also features a second line plot which represents the same data as the first, but only considering every n-th month's observation value. The n-value is given by the user through another slider below the plot.



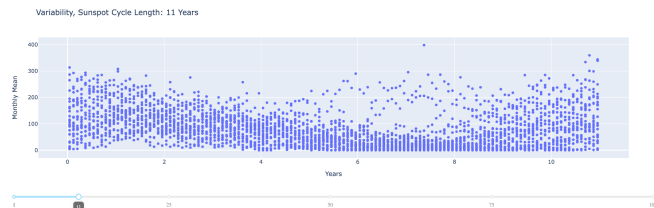
Plot showing monthly means of entire observation set



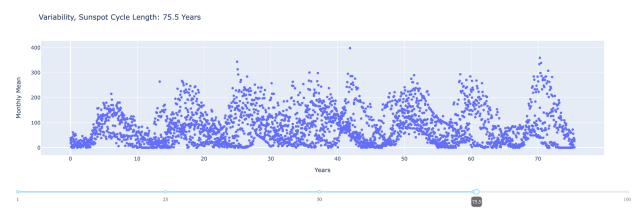
Line plot showing monthly means from 1985 to 2022

These plots show very well how the sunspot monthly mean changes every month with a similar pattern being followed every 10 or so years. The peaks and lows of these cycles have not greatly differed very often from their norm. However, there are some outliers. For example, the cycles around 1805 and 2015 both had relatively low peaks with monthly means of 103.4 sunspots and 146.1 sunspots, respectively. On the other hand, the ones around

1790, 1850, and 1970 seem to have relatively high peaks, being a respective 290 sunspots, 298.3 sunspots, and 192.3 sunspots. The lows for each cycle are all about the same, minimizing from just above 0 sunspots to 20 sunspots every cycle. This variability across the different cycles can actually be seen more readily by compressing each cycle in the line plot into a single scatterplot. This can be done by reassigning each date as the modulo between the fractional year (for example, 2020.135) and the assumed cycle length in years. The scatterplot features a user-friendly slider which can reassign the assumed cycle length.



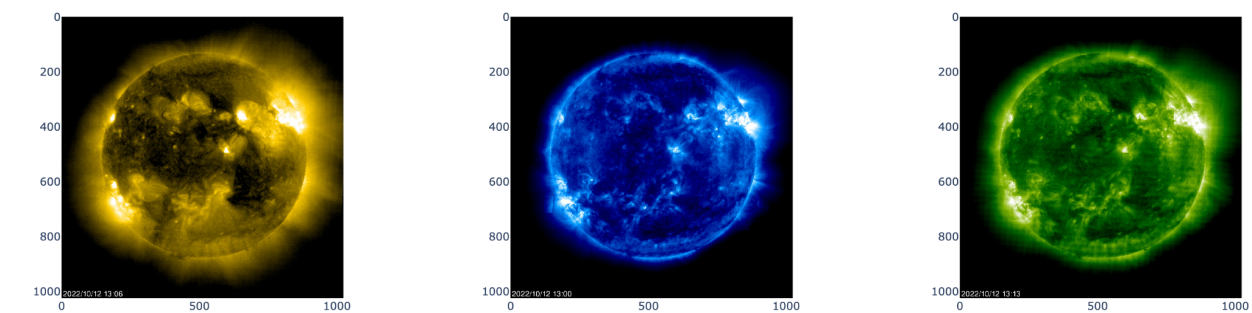
Scatterplot showing variability of cycle length 11 years



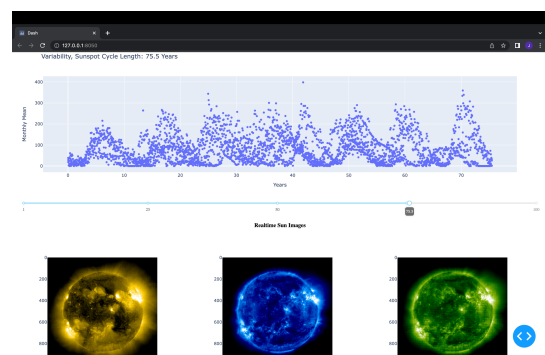
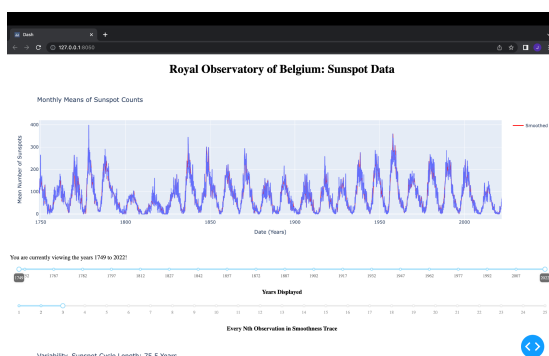
Scatterplot showing variability of cycle 75.5 years

This technique of viewing the different cycles overlaid together is interesting because it shows an imitation of the shape of the cycles seen in the unmanipulated data's line plot. With the true cycle length of 11 years, the scatterplot takes on the shape of one cycle of solar activity whereas with an extremely overestimated cycle length of 75.5 years, the shapes of about 7 cycles can be seen. This makes sense because $75.5 \% 11 = 6.86 \approx 7$.

Finally, the dashboard includes a trio of real time sun images with different filters. These images are courtesy of NASA, and provide quite an interesting perspective of the sun even for those without knowledge of what the multicolored filters mean!



Realtime sun images



Royal Observatory of Belgium: Sunspot Data dashboard

REFERENCES

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