Extended Abstract: SunDash Monitoring and Analyzing Solar Activity

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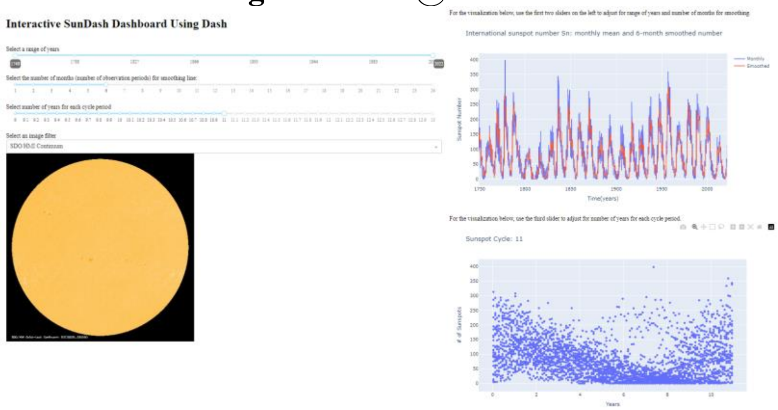
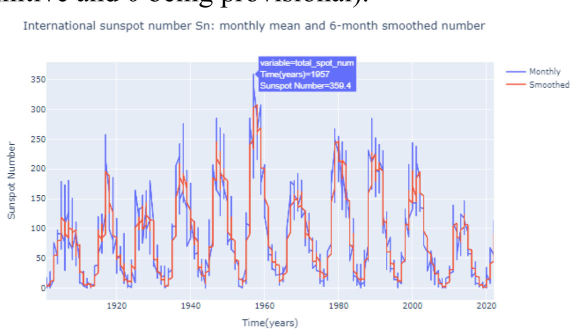


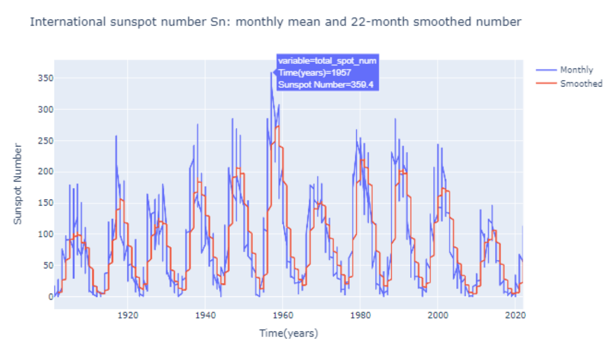
Introduction/Background:

The Royal Observatory of Belgium provides the SIDC or Solar Influences Data Analysis Center. It provides sunspot counts over the past 270 years. There are two visualizations as well as images of the sun shown in this visualization. The user can use the filters to adjust the views of the visualizations and images. Friendly messages are indicated above each visualization to let the user know which filters to use.

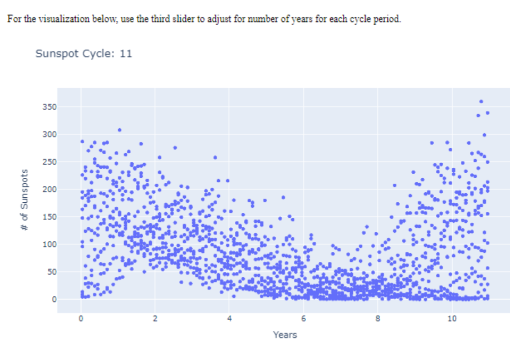
Data Sources/Methods/Analysis:

The dataset used for this dashboard is from SILSO or Sunspot Index and Long-term Solar Observations. It has the monthly mean total sunspot number. The first two columns represent the Gregorian calendar date (year and month). The third column represents the date in a fraction of the year. The fourth column represents the monthly mean total sunspot number. The fifth column represents the monthly mean standard deviation of the input sunspot numbers. The sixth column represents the number of observations used to compute the monthly mean total sunspot. The seventh column represents the definitive/provisional marker (1 being definitive and 0 being provisional).

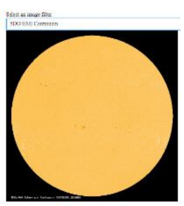




The first plot on the top right of the dashboard shows the monthly mean total sunspot number over a user-defined range of years. For the smooth data line, the rolling average method based on the number of user-defined months is used. For the range slider for selecting the range of years to look at, 1749 to 2022 is the default range since the data provided includes all data from those years. The marks on the slider is for every 39 years, as separating the entire range of 1749 to 2022 that way makes the slider look cleaner. However, the user can still select any year (not just years that land on every 39 years). Regarding the other slider, it focuses on a user-defined number of months for computing the rolling average for the smoothed line. User can choose between 1 and 24 months with a step of 1. Showing up to two years of smoothing is enough to see that the smoothing line is much smoother than the regular line plot. Moreover, when taking a step back to look at the line plot, it takes a cyclical shape going up and down through the years, suggesting that during similar months of different years, there are typically more or less total sunspots. If the user adjusts the smoothing filter, say from 6 months to 22 months for averaging over the same range of years, it is clear (as shown above) that the smoothing line is much smoother for the 22 months as opposed to 6 months. It is also interesting to see how 1957 and the years directly before and after it seem to have the greatest total number of monthly sunspots.



The second plot below that shows the variability of the sunspot cycle depending on a user-defined length of a sunspot cycle. The method used here is taking the fractional year and dividing that by the modulus of the cycle length. Essentially, this method is putting all the data points into a range from 0 to the cycle length defined by the user, therefore overlaying each cycle upon itself. The slider allows user to choose from 9 through 13 years with a step of 1/10 because it is previously estimated that the cycle length is around 11 (which is set at default). Therefore, seeing plus or minus 2 years from 11 years with tuning of 1/10 of a month is sufficient to determine if 11 is truly the year with the least variability of data points. After playing with the cycle length filter, the user can conclude that the true cycle length is closest to 11 years as it has the least variability of the data points.



These are images of the sun based on different imaging filters, which could be selected be the user through using the dropdown. The images are from NASA's SOHO or Solar and Heliospheric Observatory. The user can choose from 8 different filters, which is neat since the sun looks different in each one of them. For instance, we can compare the EIT 171 to the default SDO/HMI Continuum. They have different colors as well as different features such as the EIT 171 having some sort of radiating glow.

Conclusion:

In conclusion, the visualizations on this dashboard provide a comprehensive understanding for users regarding historical and trending sunspot activity. The first visualization, the line plot, clearly shows the total monthly sunspots over time as well as the average values over a given time. The second visualization, the scatter plot, clearly shows users how the sunspots vary based on the cycle length and suggest that 11 years is the true cycle length. Through both visualizations, it takes in user-defined years and months to allow users to zoom in on data they may be more interested in. Lastly, the real-time images under different image filters provide users with a clear picture of the sun. The user, here, is once again given the choice with a dropdown menu of deciding which filter to see the sun under.

References:

"Silso: World Data Center for the Production, Preservation and Dissemination of the International Sunspot Number." *SILSO | World Data Center for the Production, Preservation and Dissemination of the International Sunspot Number*, https://www.sidc.be/silso/.

"Solar Influences Data Analysis Center." *SIDC*, https://www.sidc.be/.

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