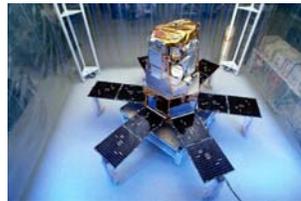


Solar Spectral Irradiance Variability

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Abstract: Facular Brightening in sunspots and active regions increase the solar irradiance and contribute to solar variability. Here, we use solar spectral irradiance (SSI) data from the SORCE mission to compare quiet sun days with active ones. Using the fractional difference between quiet and active days, one can estimate of how much solar variability can be caused by Facular Brightening.



Courtesy: NASA

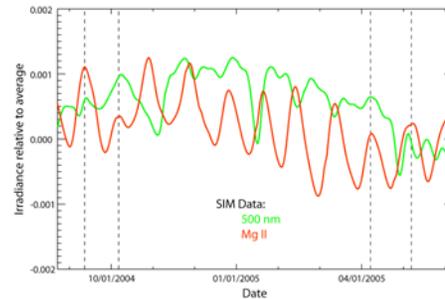
The SORCE (Solar Radiation and Climate Experiment) Mission was launched on January 25, 2003. The main reason for the SORCE mission was to provide better Total Solar Irradiance (TSI) and Solar Spectral Irradiance (SSI) data. The SSI measures the irradiance of wavelengths from 1nm up to 2400nm, which accounts for about 95% of the TSI.



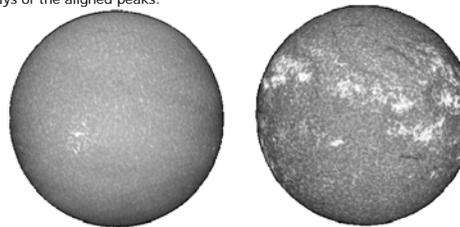
Courtesy: SOHO

As we all know, the sun is vital to all of life's existence on earth and without it, the earth would be a frozen wasteland. If this alone isn't enough reason to study all we can about our local star, the reason to study SSI is still clear. Since the sun does not vary consistently over all wavelengths, having a better understanding of the variations of the solar spectra is key to understanding how large-scale irradiance changes could have occurred and what caused them. An example of one occurrence is the Maunder Minimum, where the global average temperature dropped by approximately 0.3-0.4°K (this temperature drop could be caused by a 0.5% decrease in the TSI) (Reid et al. 1999).

Goals: From studying the variations in SSI of cases with Facular Brightening (FB), we hope to better understand how much FB influences the TSI. With the knowledge of how FB affects the TSI of the sun, it is possible to make estimates of what would happen to the TSI if Facular Brightening was dormant, and stopped occurring. From these estimates, one can approximate what the temperature affect on Earth would be for the TSI decrease. One could then use the TSI fluctuation and see if it may have been a part of the cause for the Maunder Minimum.

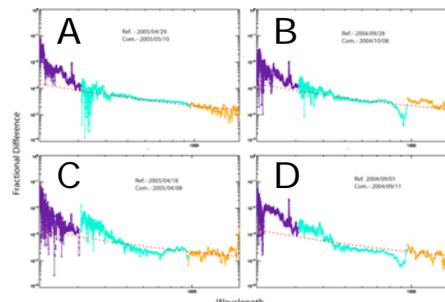


In the above plot, the irradiance changes of 500nm, used as a representative of visible light, and 280nm (Mg II) are shown. The vertical dashed lines are placed to indicate where the peaks occur near the same time, an indicator for Facular Brightening. These days were then compared to quiet sun days, days with low active network, within twelve days of the aligned peaks.



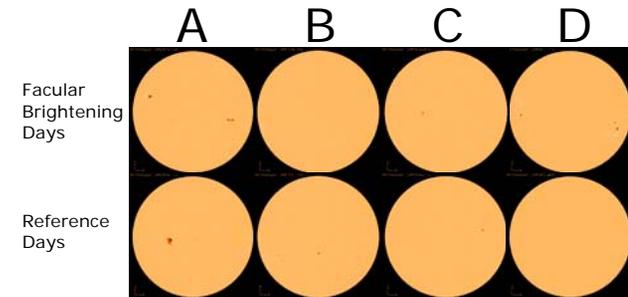
Courtesy: BASS2000

Here are two images of the sun looking at the Ca II K₃ line. The Ca II K₃ pictures are used to view the active network on the sun. By using images like these, we can get focus closer on the days of Facular Brightening. It is important to note that in order to get good data for the results from Facular Brightening, we must also look at visible light images of the sun to find days that also have a minimal number of sunspots.

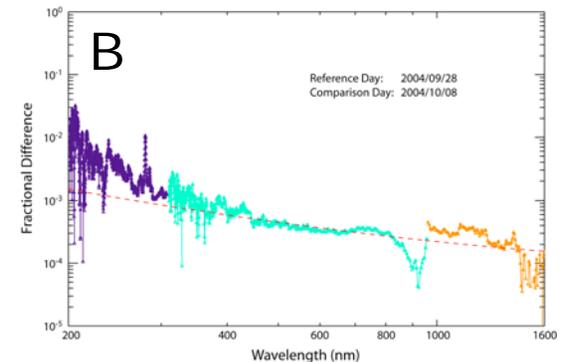


Here are the plots of the four dates of FB. The Fractional Difference (Ratio - 1) is shown versus wavelength. The dashed red line is the Plank derivative of a black body with a 0.4°K increase in temperature at 5780°K. Aside from the instrumental artifact around 900nm in a few of these plots (due to instrument heating), the visible and IR ranges of the wavelengths, teal and orange respectively, fit the 0.4° variation well. The UV (purple) data shows a bit larger of an increase in these cases.

In order to sift through these results for the data most attributed to FB, we must also look at the solar images for these days to find which set has the least interference from sun spots.



From these solar images courtesy of the Michelson Doppler Imager (MDI) web site, we can see that B and D have the least interference from sunspots, with B having the least. Thus, since B has the least amount of sunspots present, the fractional difference plot for this set is represents our desired data.



Conclusion

Again, without paying attention to the feature near 900nm that is caused by instrument error due to heating calibrations, we see that most of the variations fit well to the 0.4° increase for blackbody radiation. We also see the higher increase in UV than the 0.4° increase for a blackbody.

With the data provided from this plot, estimates for how much it effects the TSI are possible. From there, climate modelers can use that data to simulate the approximate temperature changes that would be observed on Earth. For a drop in TSI of 1%, the average global temperature would decrease by about 0.5-0.6°K. (Reid et al. 1999)

Works Cited

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