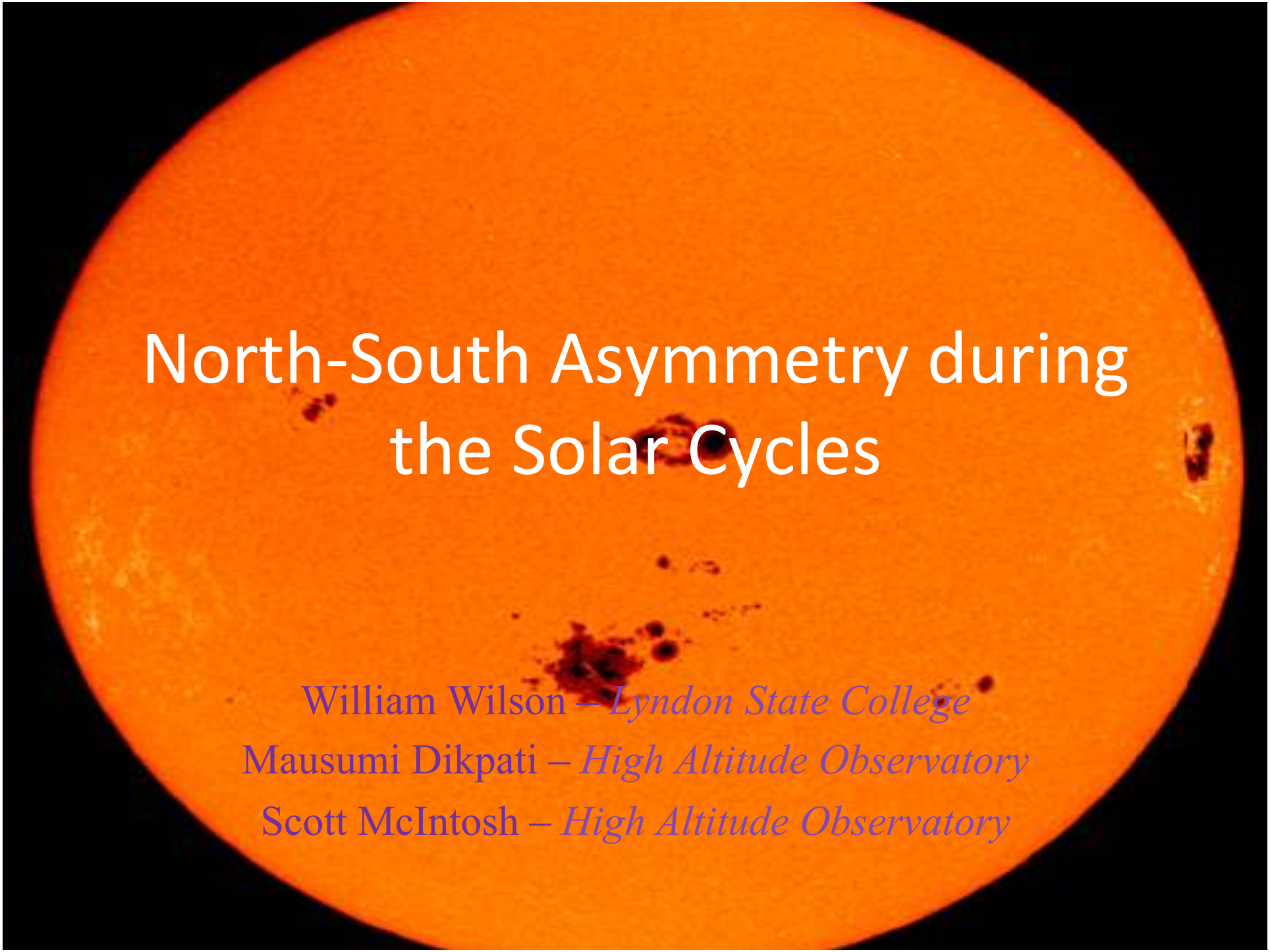
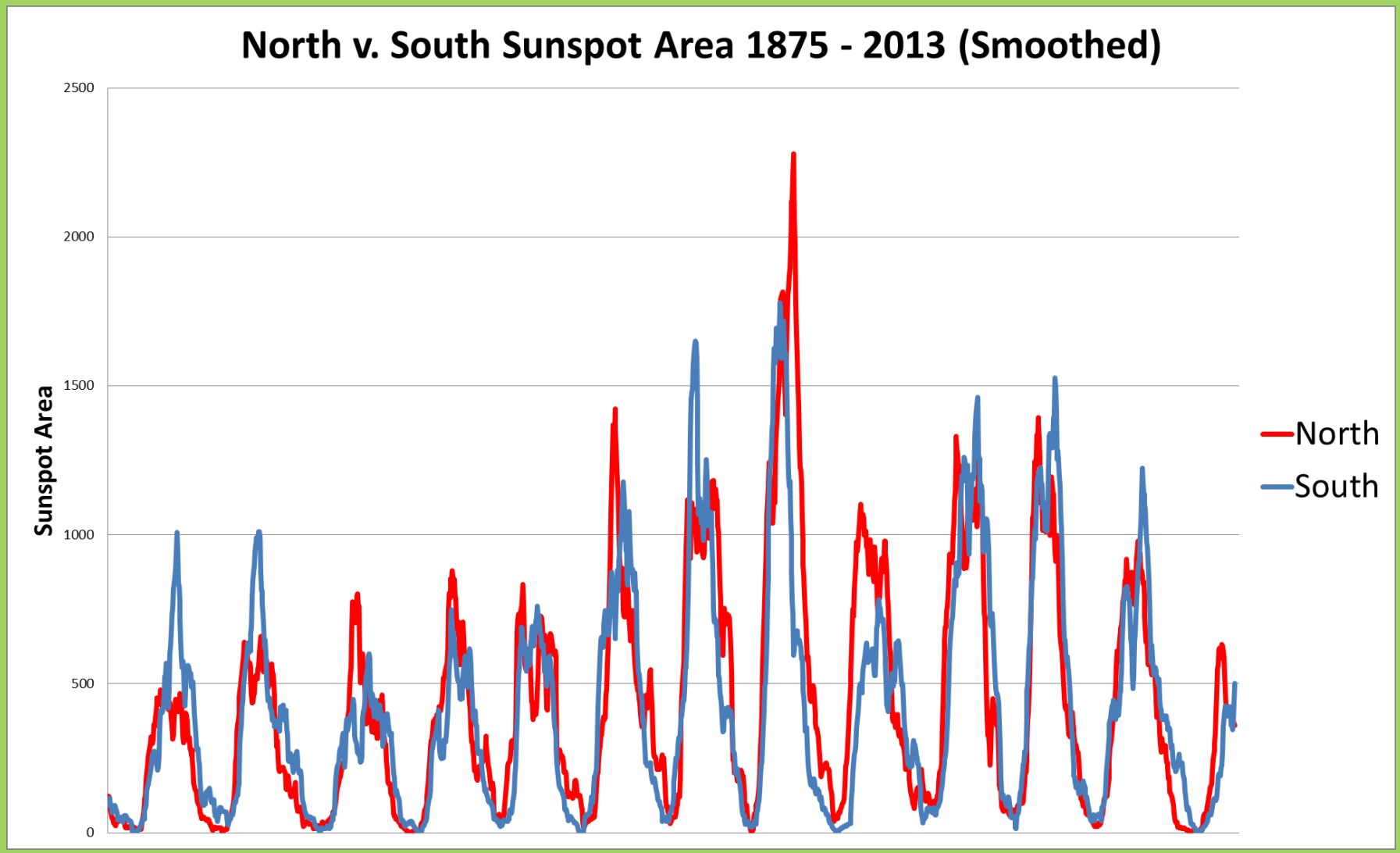


North-South Asymmetry during the Solar Cycles

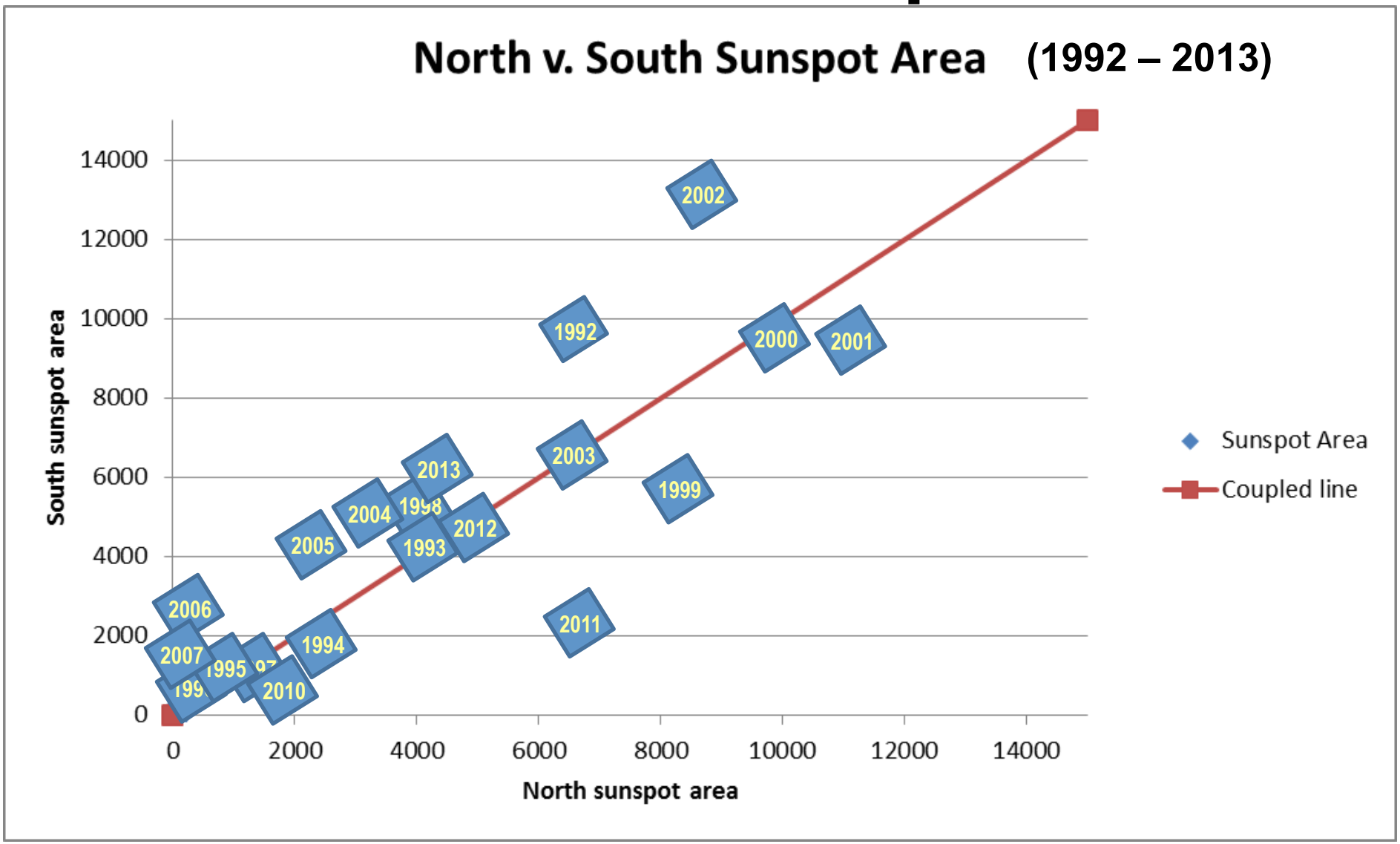
William Wilson – *Lyndon State College*
Mausumi Dikpati – *High Altitude Observatory*
Scott McIntosh – *High Altitude Observatory*

North and South Sunspot Area during 1875-2013

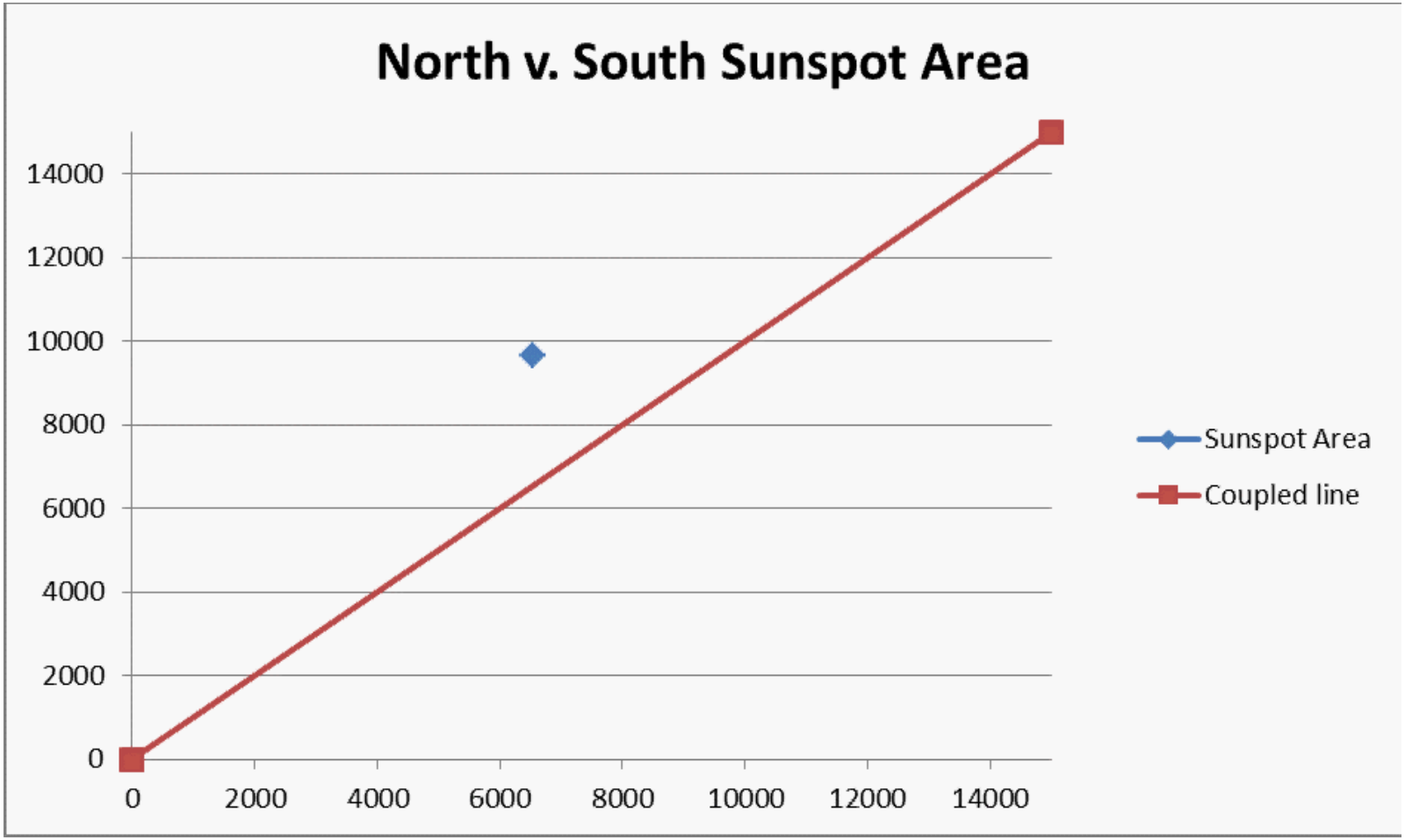


Raw Sunspot area data from the NASA Marshall Space Flight Center

The Sun's natural tendency of coupling North & South hemispheres



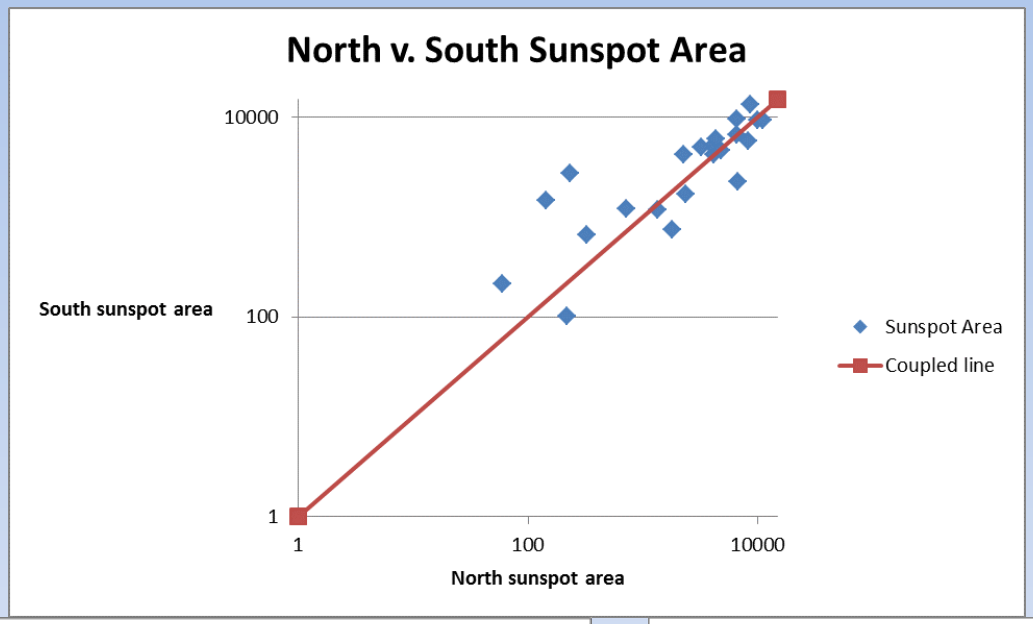
The Sun's natural tendency of coupling North & South hemispheres



More evidence for North-South Coupling

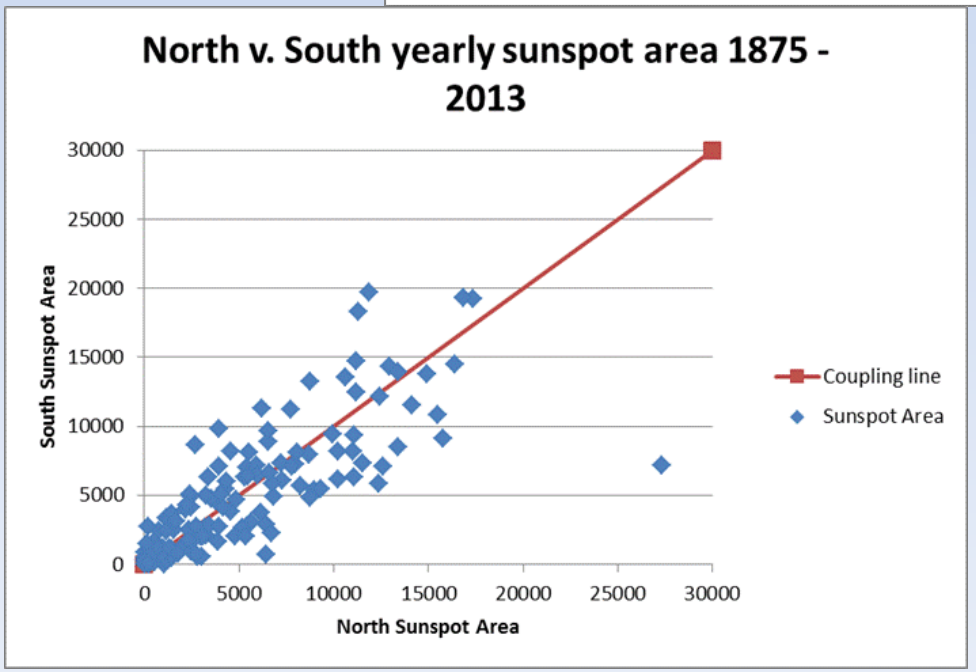
To the Right

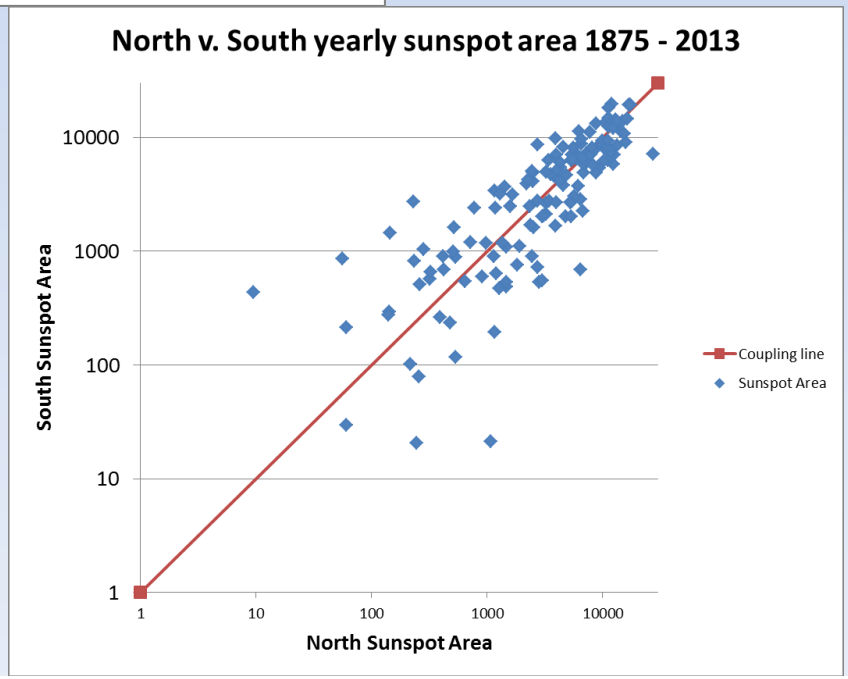
North-South yearly average sunspot area from 1992 to 2013 in logarithmic format



Bottom

North-South yearly average sunspot area from 1875 to 2013 in linear and logarithmic format

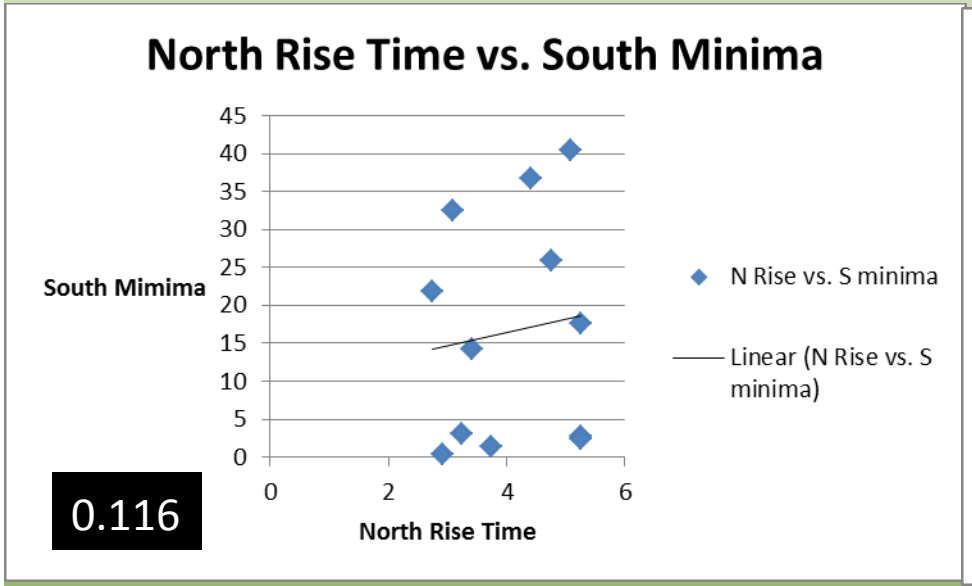


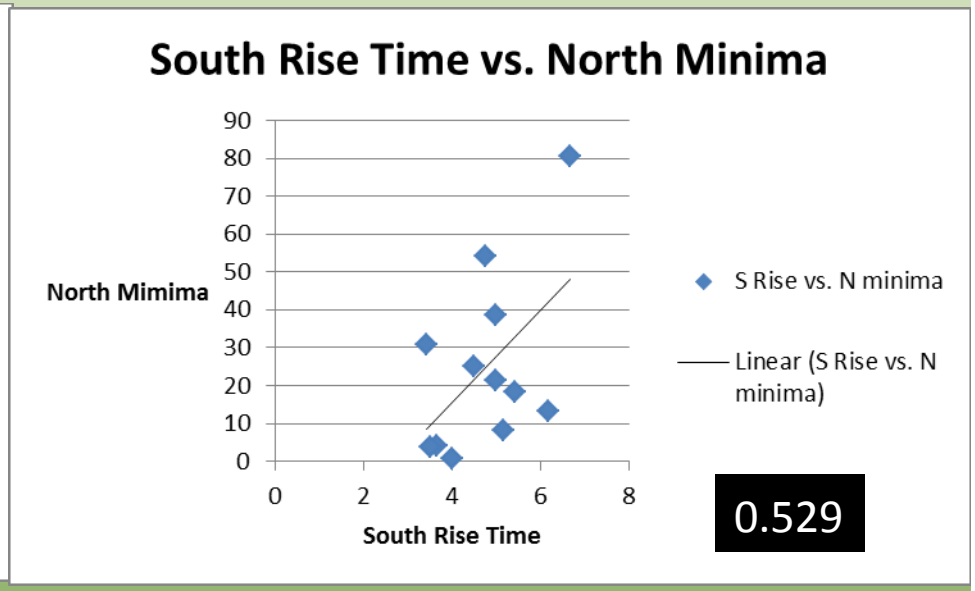


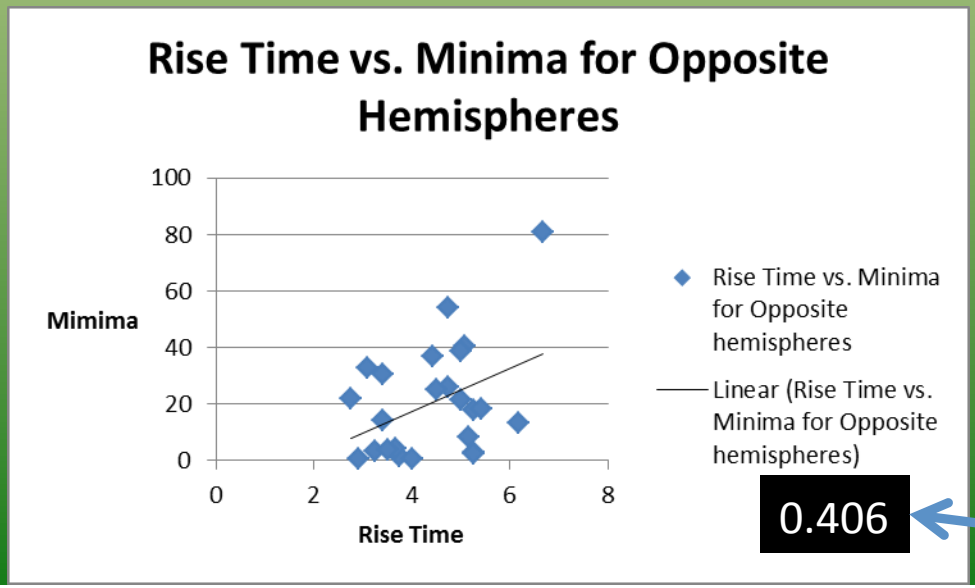
Comparing Rise Time, Peak Amplitude, and Minimum Amplitude

Rise time vs. Minima

Rise Time in one hemisphere vs. Minima in opposite hemisphere (12 month smoothing)



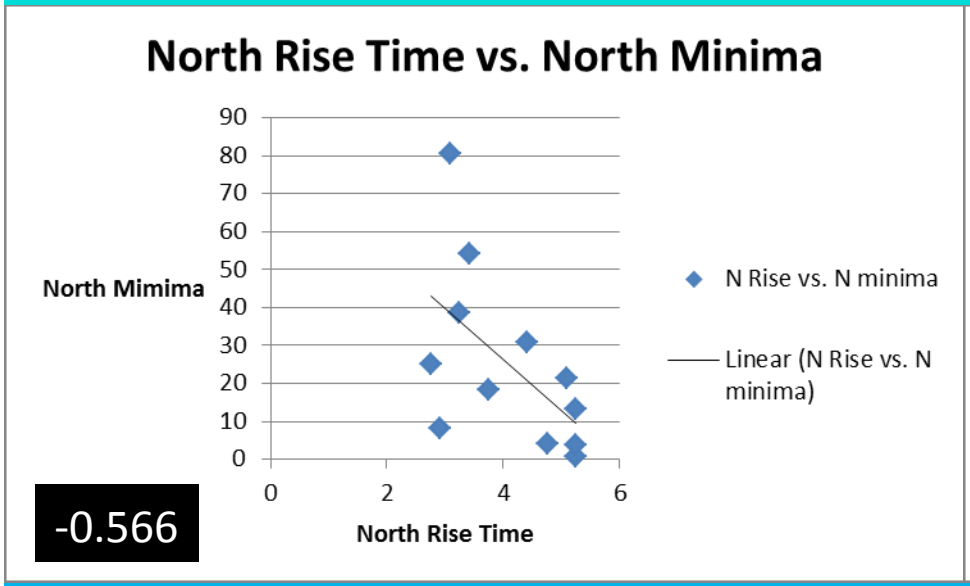


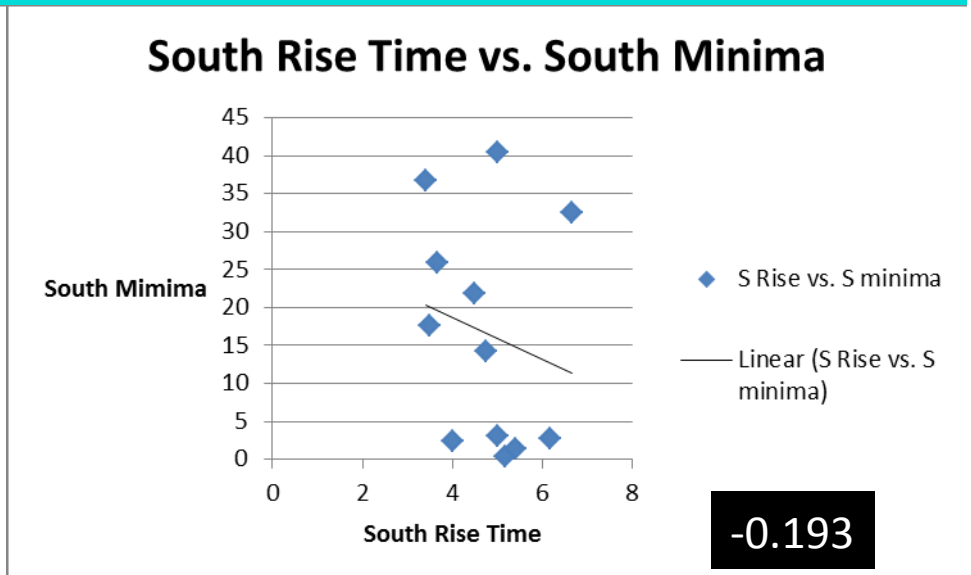


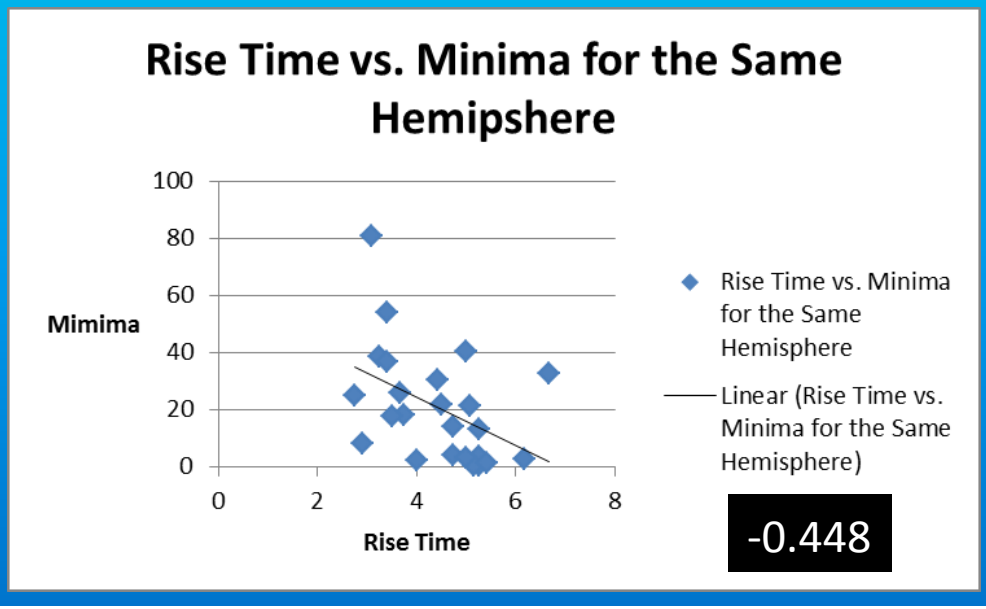
- Fast rise time in one hemisphere can cause a lower minima in the opposite hemisphere.
- Intuitively, we can expect this because one hemisphere's magnetic flux will annihilate the other hemisphere's flux

Pearson product-moment correlation coefficient

Rise Time in one hemisphere vs. Minima in the Same Hemisphere (12 month smoothing)

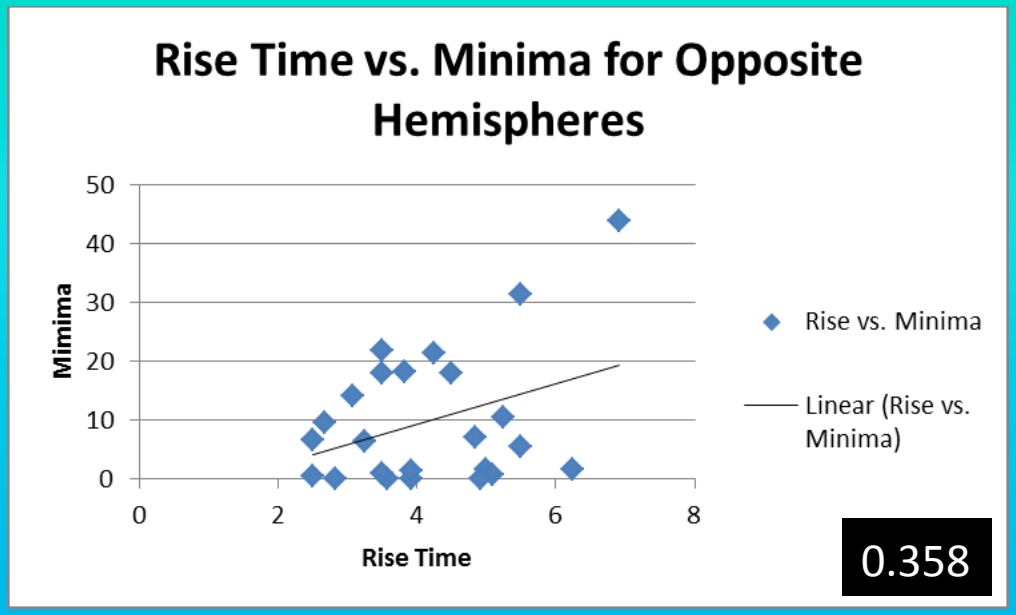


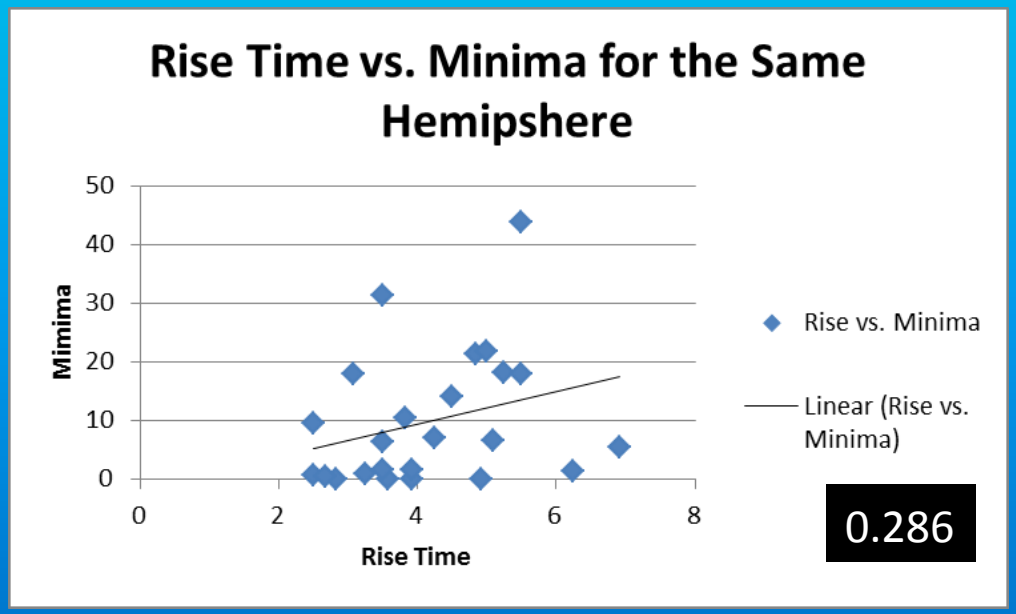




- Fast rise time in one hemisphere does not lead to a lower minima, but rather leads to a higher minima in the same hemisphere
- This is understandable because the magnetic flux in one hemisphere cannot annihilate it's own flux

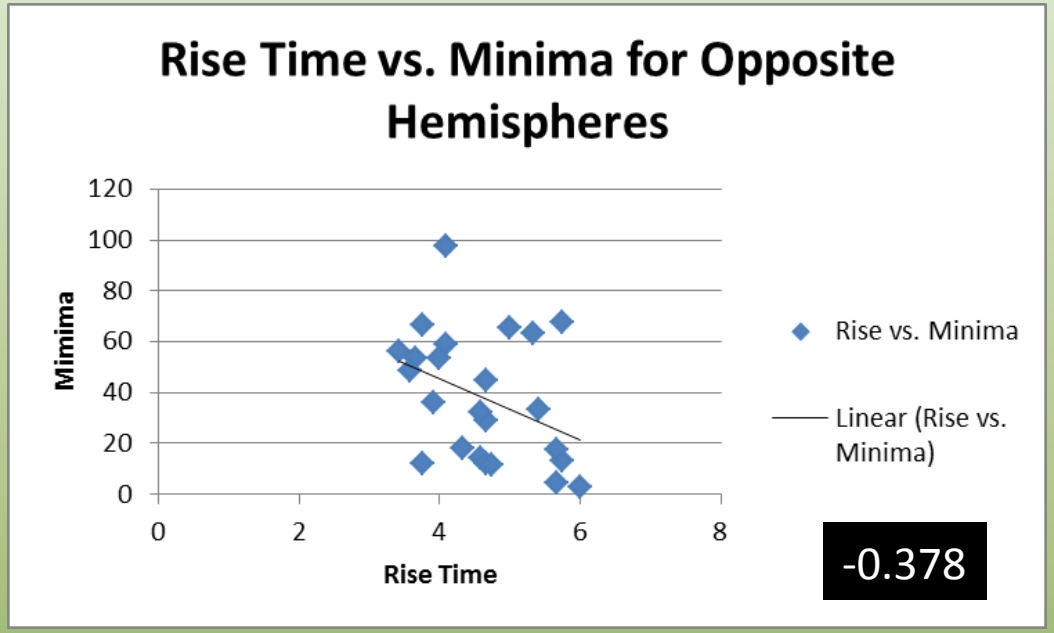
Rise Time vs. Minima (6 month smoothing)

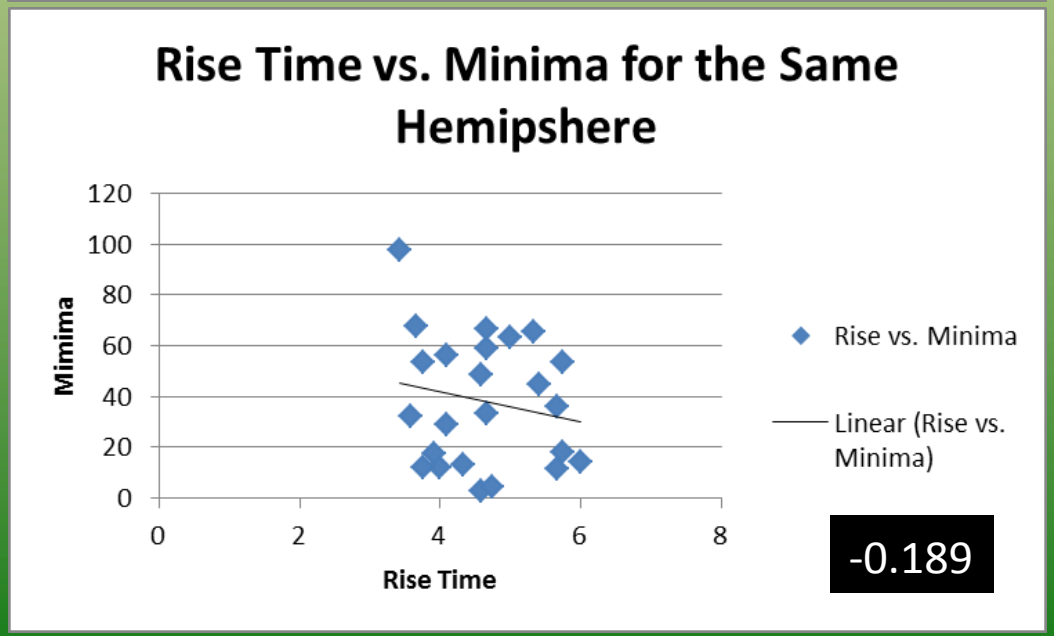




- For 6 month smoothing data, a fast rise time in one hemisphere causes a lower minima in the opposite hemisphere
- However, rise time in one hemisphere also weakly correlates with its own minima flux degrading the result

Rise Time vs. Minima (24 month smoothing)





- For 24 month smoothing, the rise time in one hemisphere anti-correlates to the minima in the opposite hemisphere as well as in the same hemisphere
- The reason for this result was likely due to too much averaging of the data causing the sunspot data to lose some important features

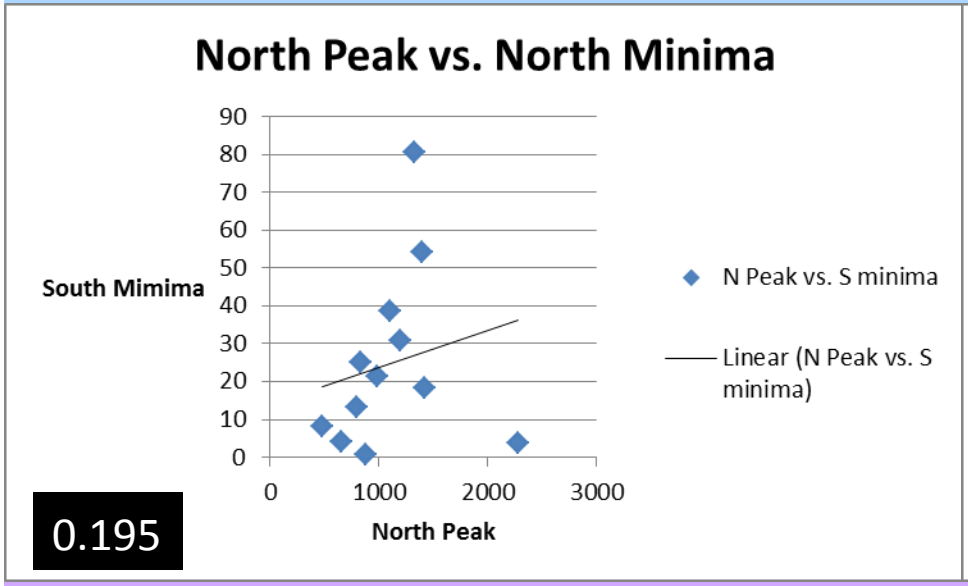
Key Results for Rise Time vs. Minima

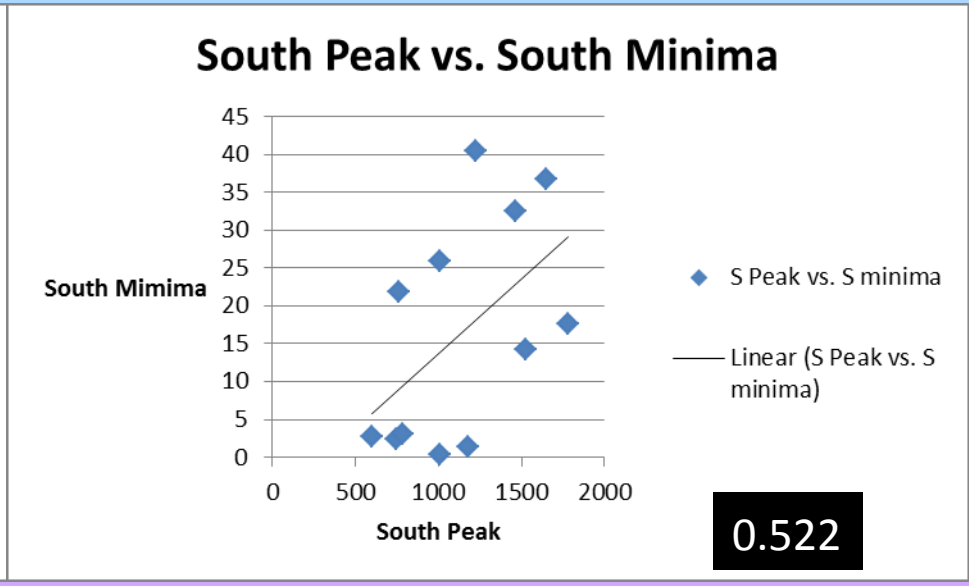
- For 12 month as well as 6 month smoothing of the data, a fast rise time in one hemisphere indicates a lower minima in the opposite hemisphere
- However, for 24 month smoothing data, a rise time in one hemisphere anti-correlates with the minima in the opposite hemisphere, likely due to too smoothing of the raw data

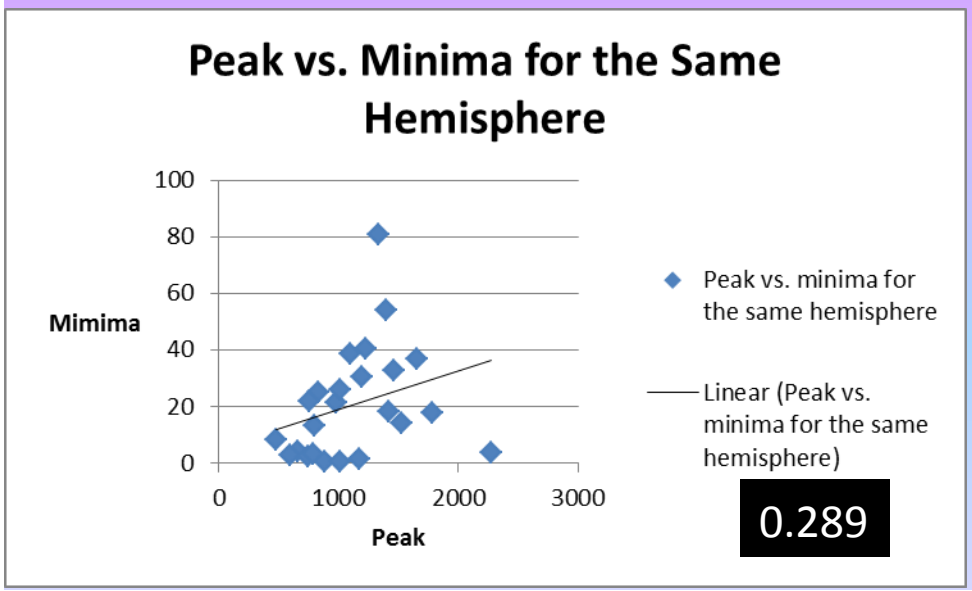
Comparing Rise Time, Peak Amplitude, and Minimum Amplitude

Peak vs. Minima

Peak vs. Minima in the Same Hemisphere (12 month smoothing)

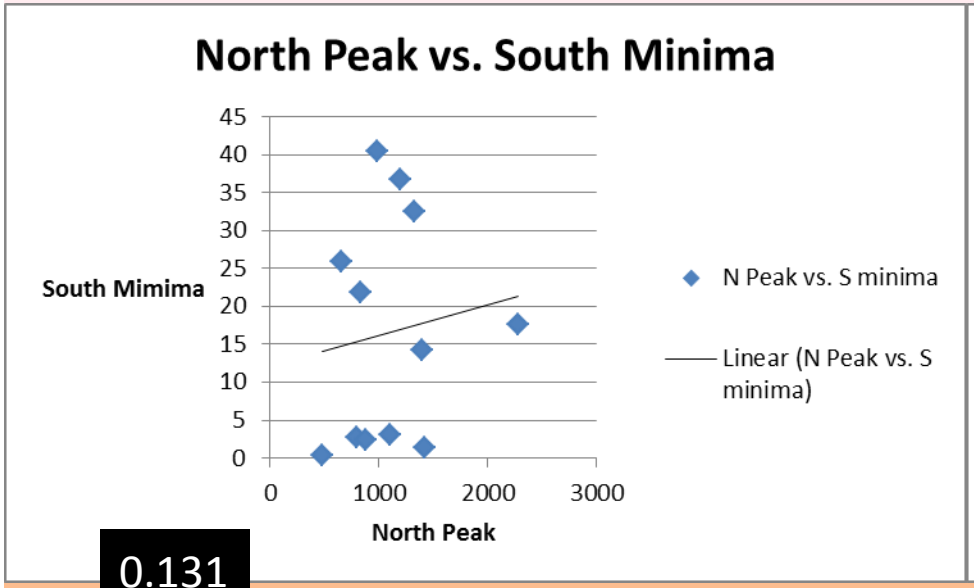




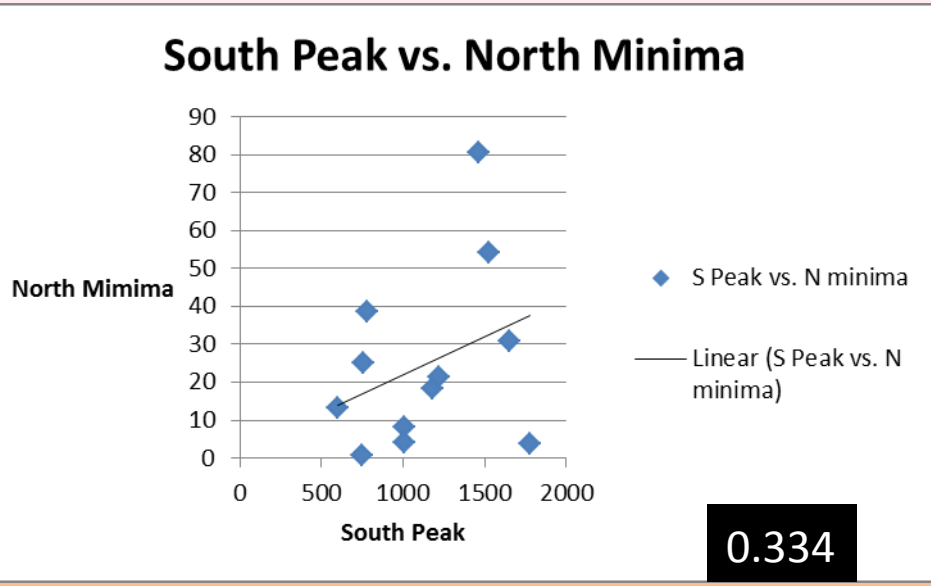


- Stronger peak appears to lead to a higher minima level in the same hemisphere
- This is what we should expect

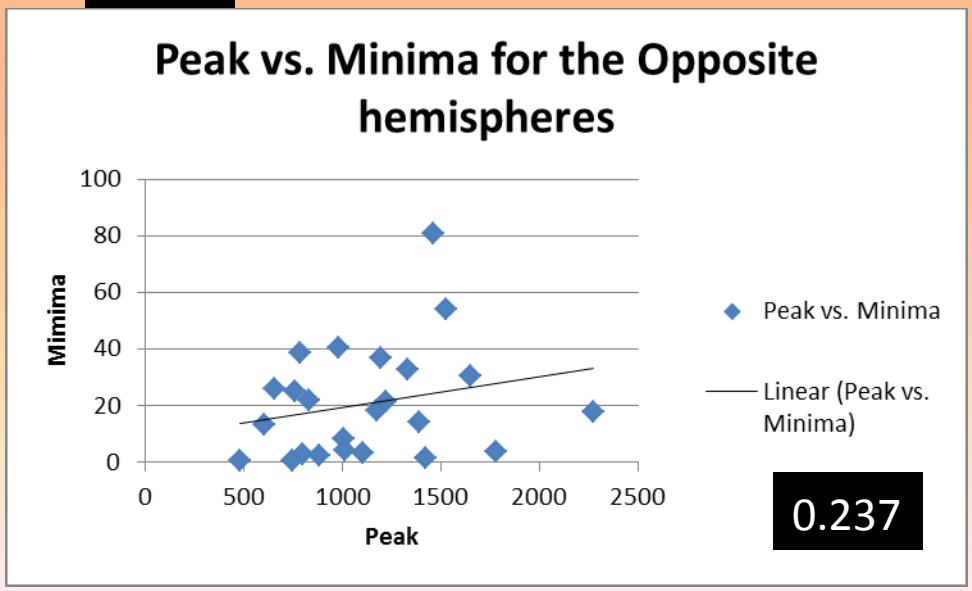
Peak vs. Minima for Opposite hemispheres (12 month smoothing)



0.131



0.334



0.237

- Interestingly, peak correlates with a minima level in the opposite hemisphere, as well
- This is counterintuitive, as the magnetic flux from one hemisphere annihilates the flux of the other hemisphere; We should expect an anti-correlation

Key results for Peak vs. Minima

- A positive correlation prevails for both the same and opposite hemispheres for 6 month and 24 month smoothing data
- Asymmetry in the peaks of north and south hemispheres does not lead to similar asymmetry in the minima level, according to the data

Conclusions

- North and South hemispheres of the sun have a natural tendency to be decoupled, but there is a mechanism that tries to couple them continuously
- 12 month smoothed data shows that there is a significant correlation between the rise time in one hemisphere and the minima level of the other hemisphere
- 6 month smoothed data shows a similar correlation between the rise time in one hemisphere and the minima of the other hemisphere
- However, 24 month smoothed data shows a weak anti-correlation between rise time in one hemisphere and minima level of the other hemisphere as well as with the same hemisphere; This is likely due to too much smoothing, which is causing a deterioration of the physics of the system
- The data shows that a bigger peak should cause a larger minima in the same hemisphere, but the peak of one hemisphere does not have as much influence on the minima of the opposite hemisphere


The End
Questions? Comments?