

Long-Term Solar Variability

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Known sources of TSI variation

- Sunspots, faculae, and flares (magnetic effects)
- Convection and p-modes (non-magnetic)
- This meeting, session 2:
Dikpati, Goode, Wang, Svalgaard,
Lockwood

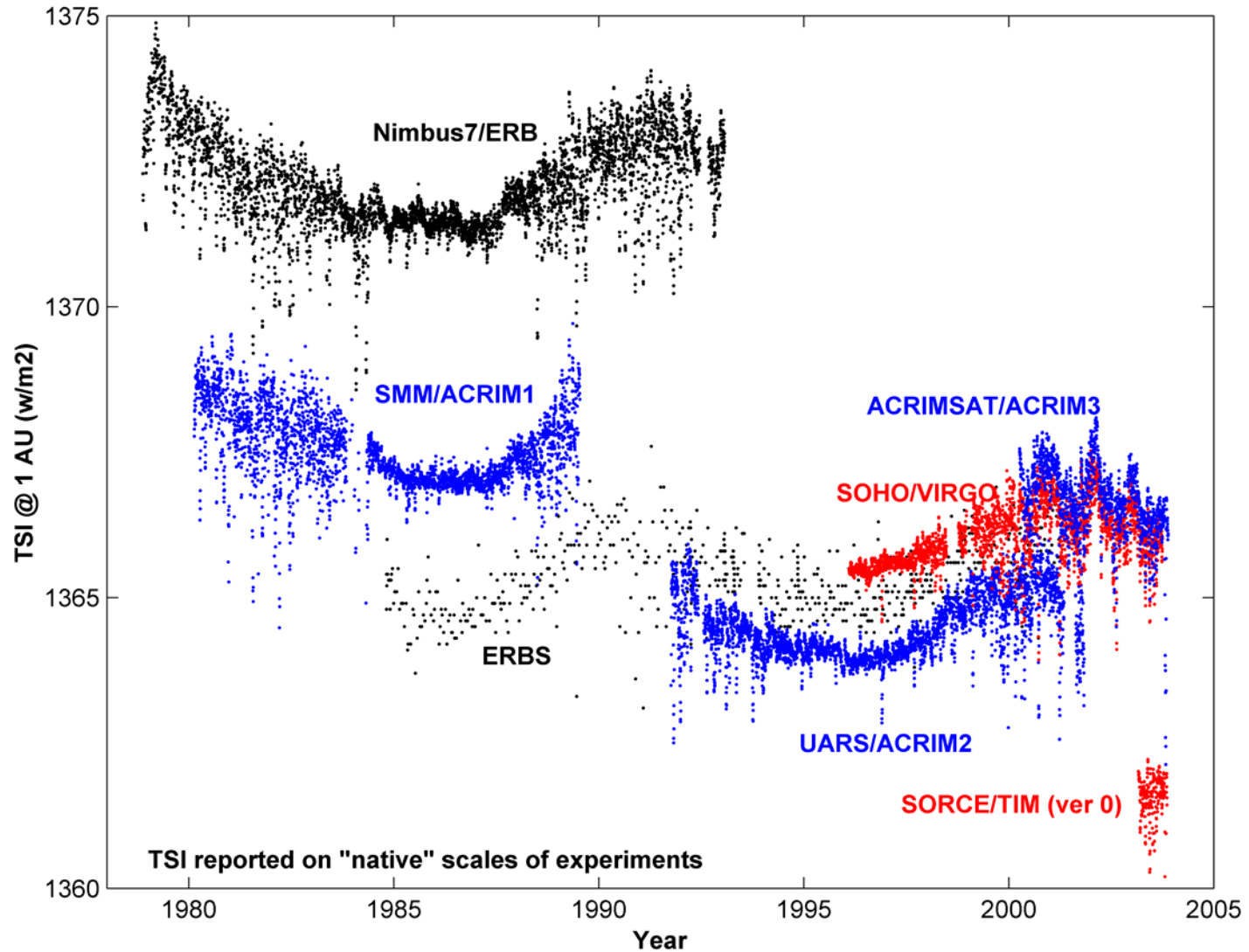
Key question

- Does inherent solar variability explain global warming?

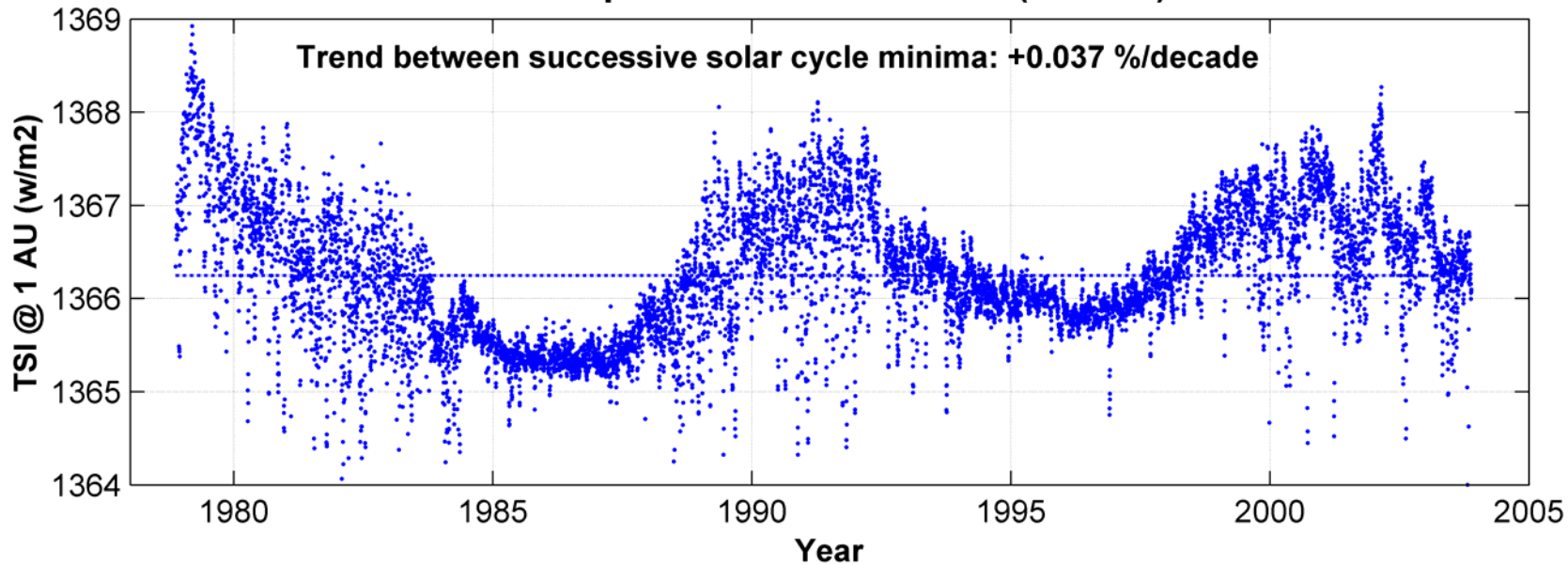
Answer to question

- We can't tell yet.
- It would be prudent to assume that it doesn't.

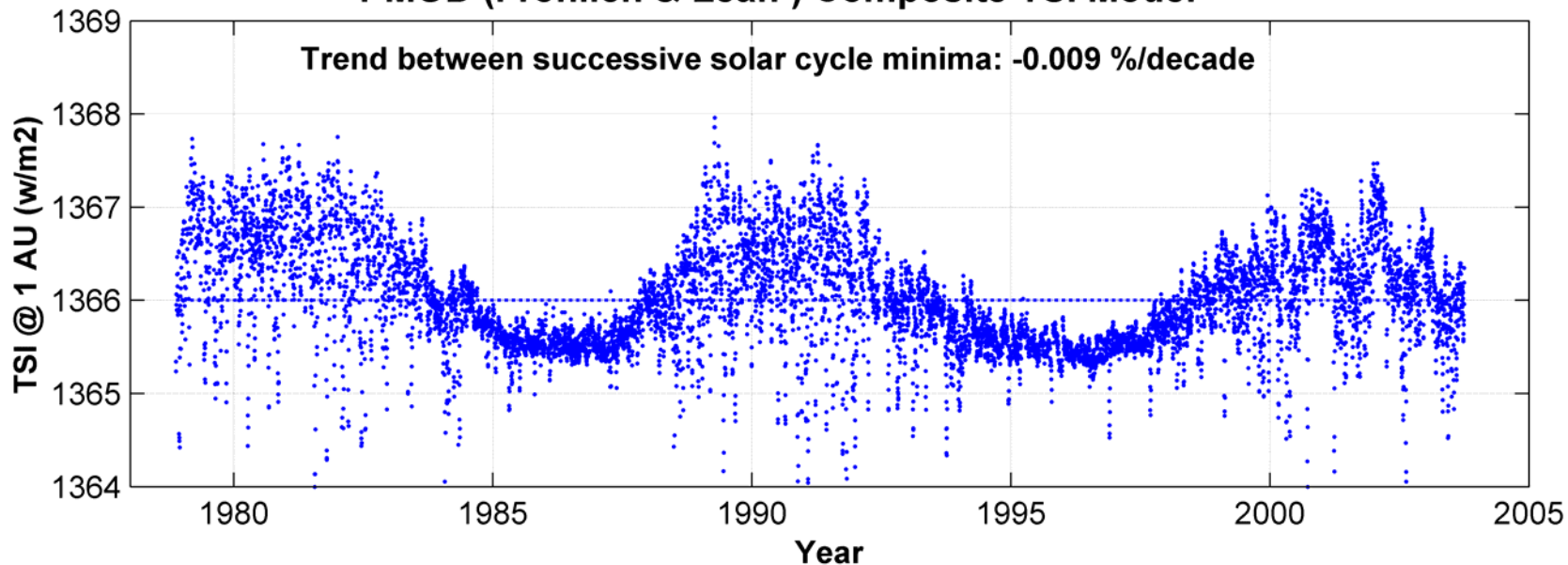
TOTAL SOLAR IRRADIANCE MONITORING RESULTS: 1978 to Present



ACRIM Composite TSI Time Series (NNAA3)



PMOD (Frohlich & Lean*) Composite TSI Model



*(Frohlich & Lean, GRL 1998)

ERBS, a simple-minded analysis for secular change:

Time-range	TSI (W/m ²)	Number of points	Formal error (W/m ²)
1985-1986	1364.68	56	0.048
1995-1996	1365.00	83	0.045

$\Delta\text{TSI} = 10\sigma!$ Is this a true irradiance change, or merely the increasing phase of the sensor degradation?

What do the limits imply?

- Our rough guess at the (uncertainty of a) secular change would be ~ 50 ppm/decade
- How rapidly could the Sun change secularly, ie independently of the magnetic effects we know about?
- Thermal time scale of the convection zone (W/L) $\sim 50,000$ years $\Rightarrow 100$ ppm/decade
- Thermal time scale of the whole Sun \Rightarrow roughly 0.3 ppm/decade

Key question

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Answer to question

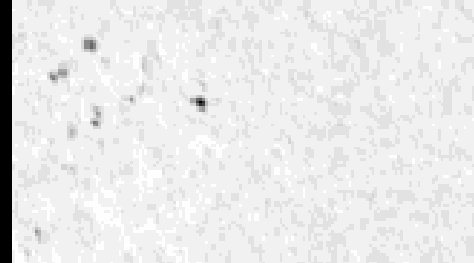
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Another mechanism for TSI variation?

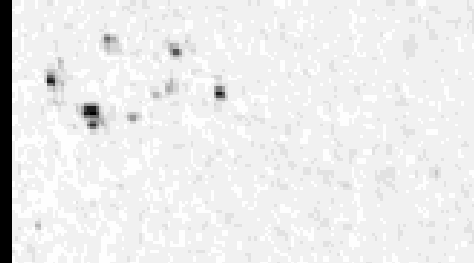
- The use of MDI data for irradiance studies
- A search for thermal effects associated with emerging flux (AGU poster SH32A-1102, Zahid et al.)



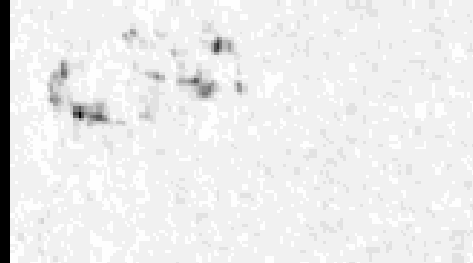
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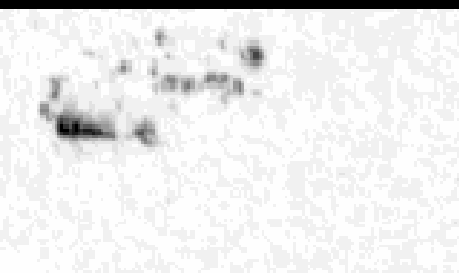
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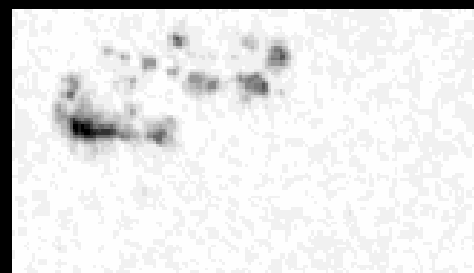
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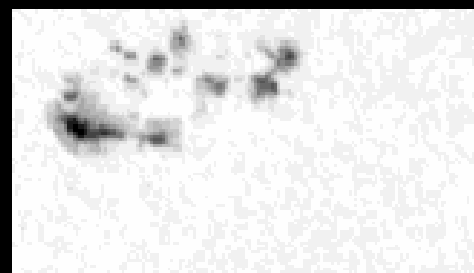
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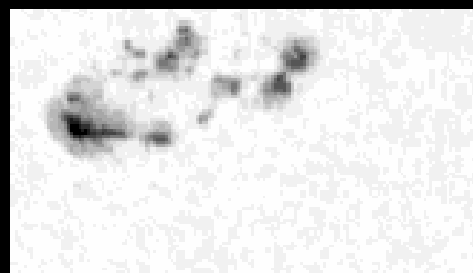
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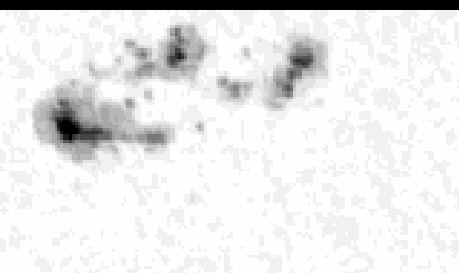
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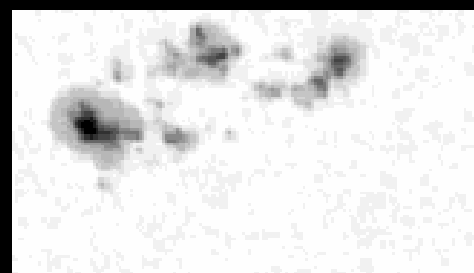
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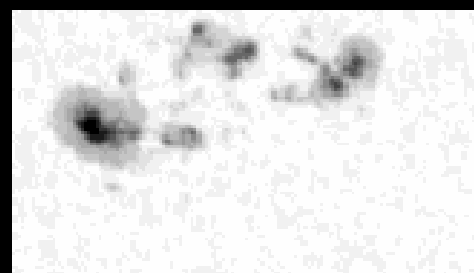
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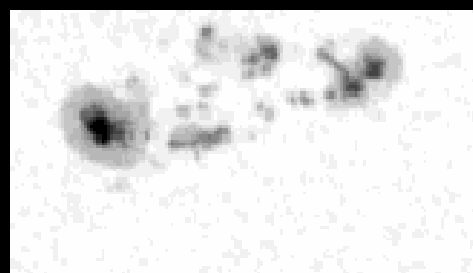
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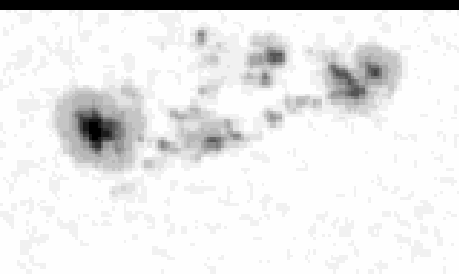
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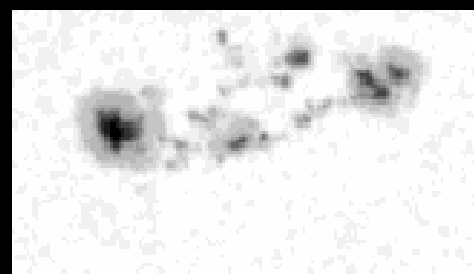
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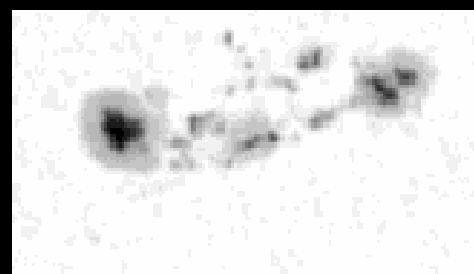
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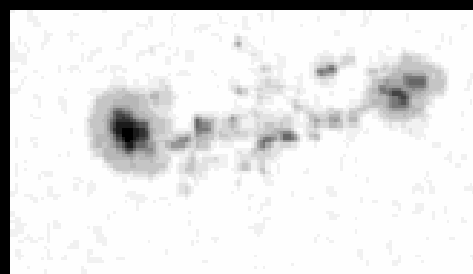
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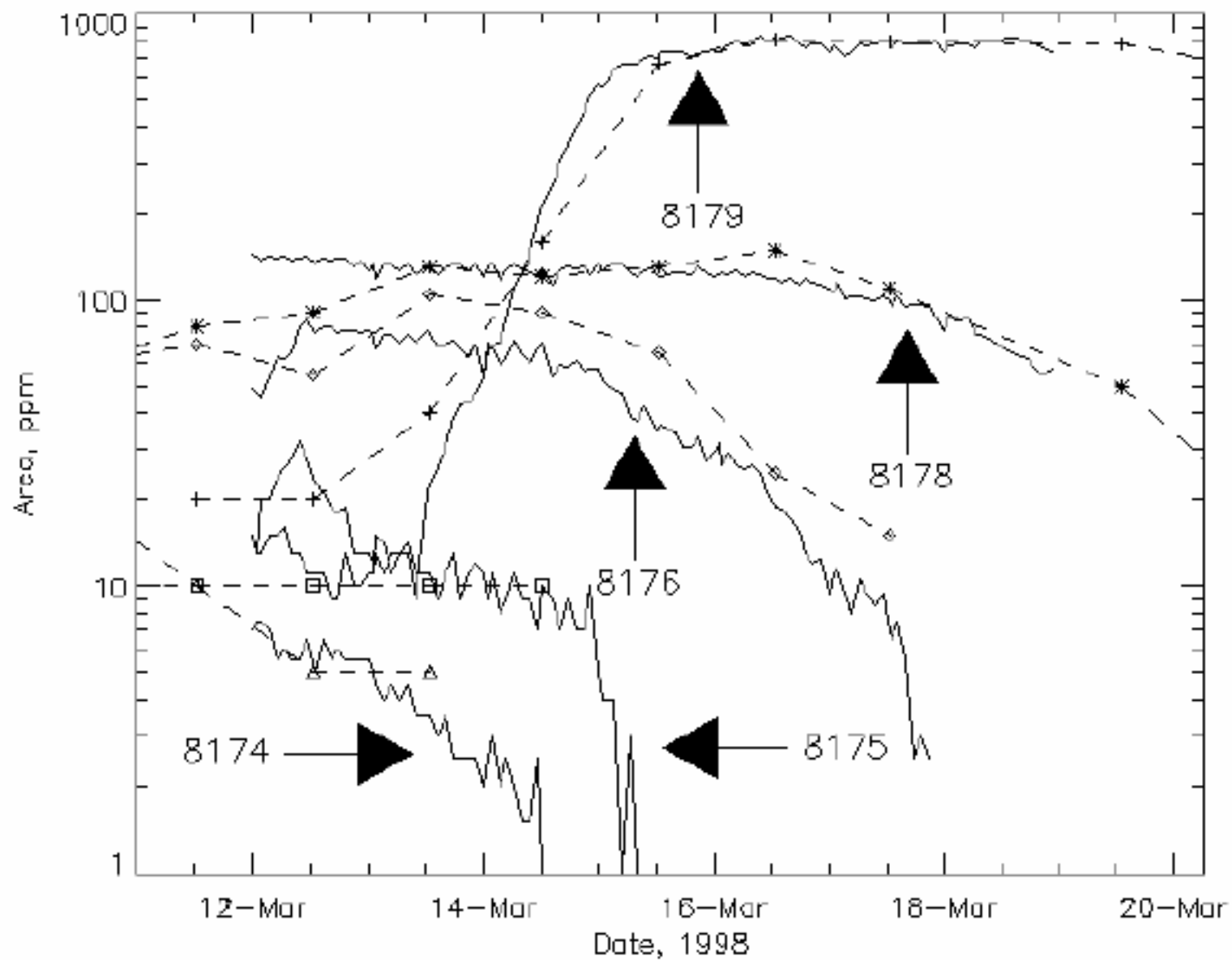
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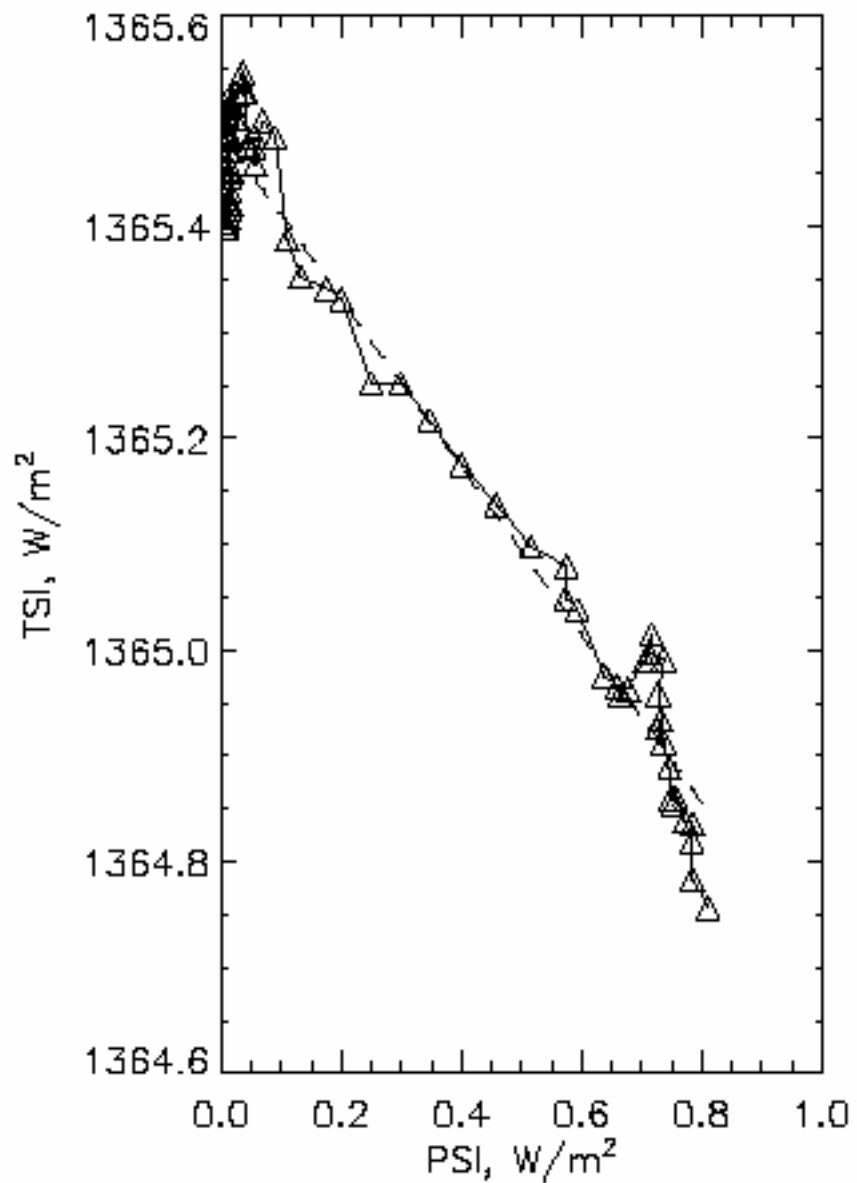
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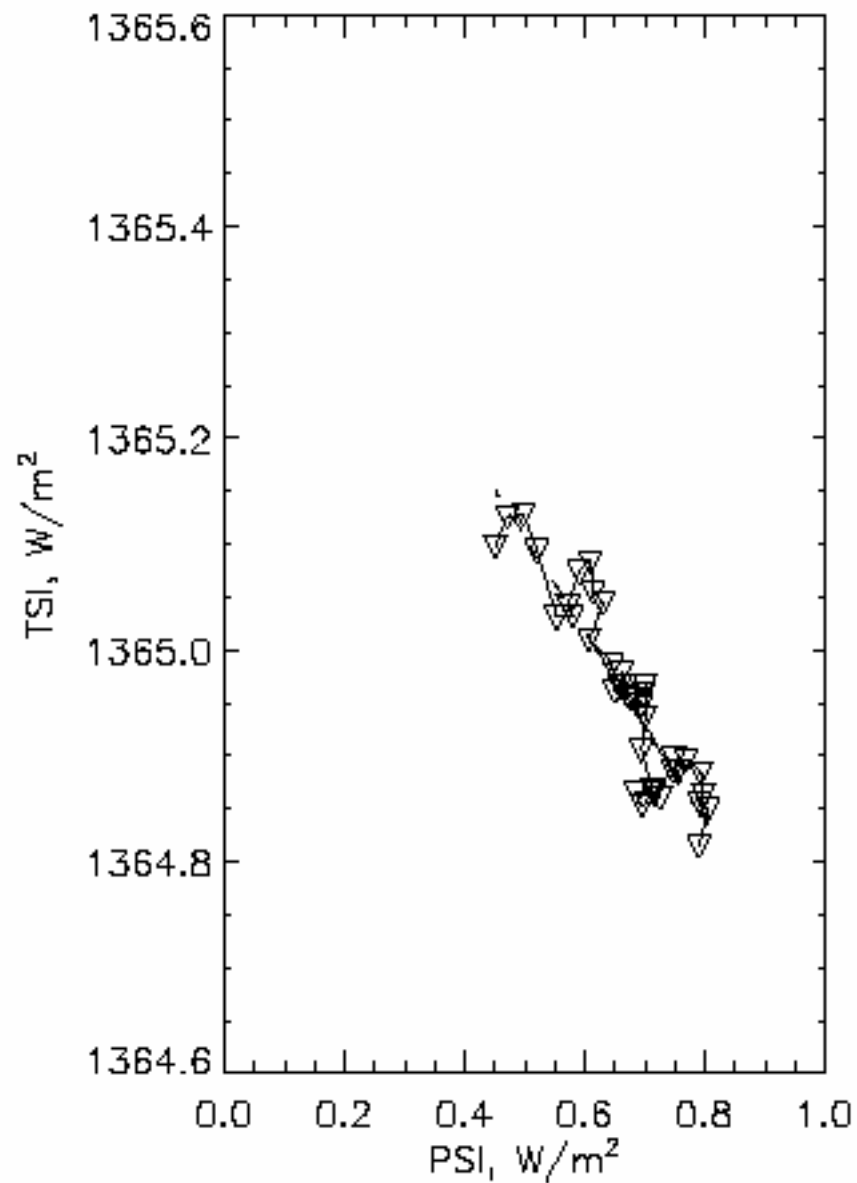
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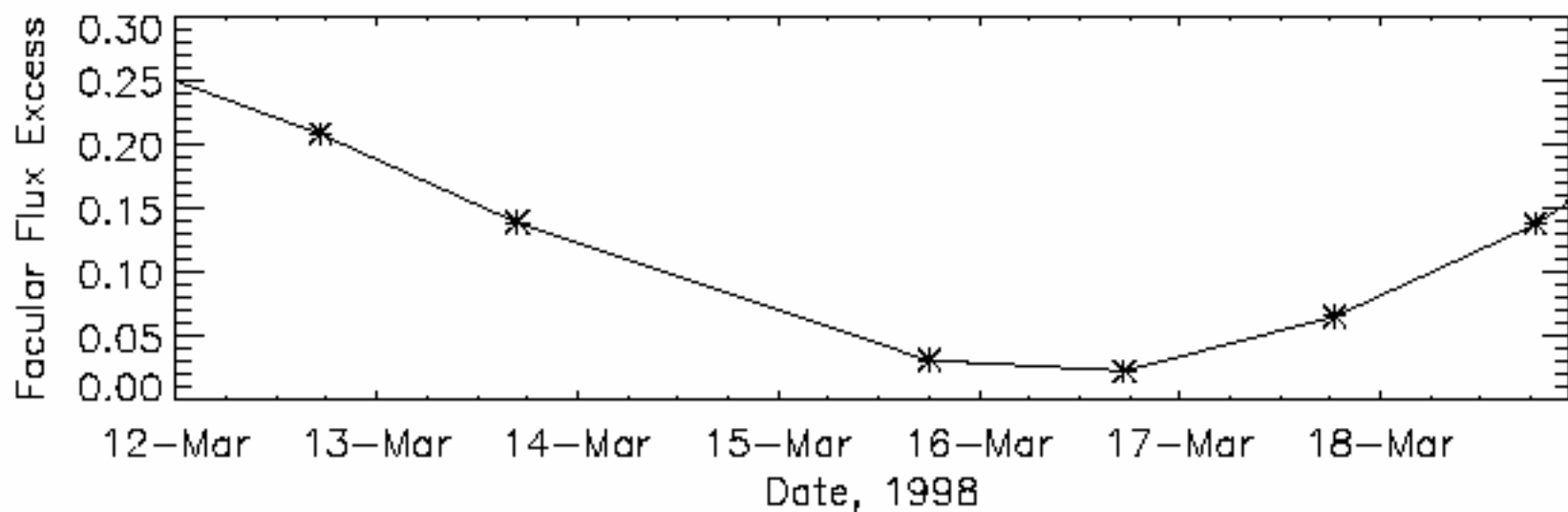
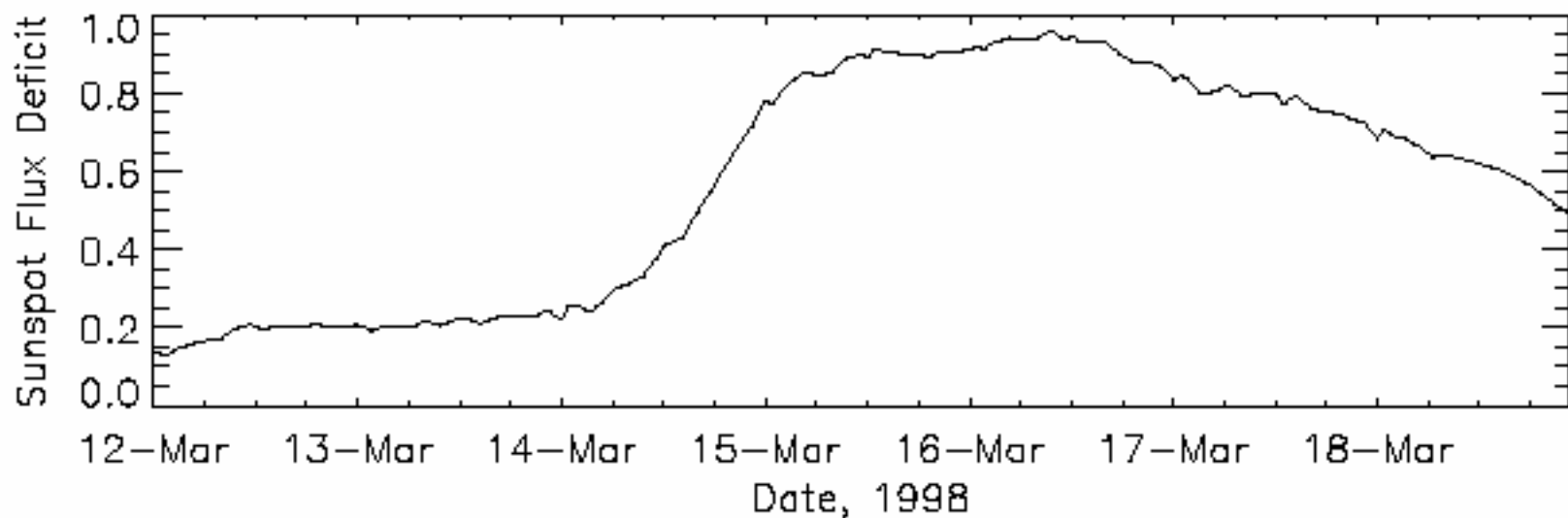


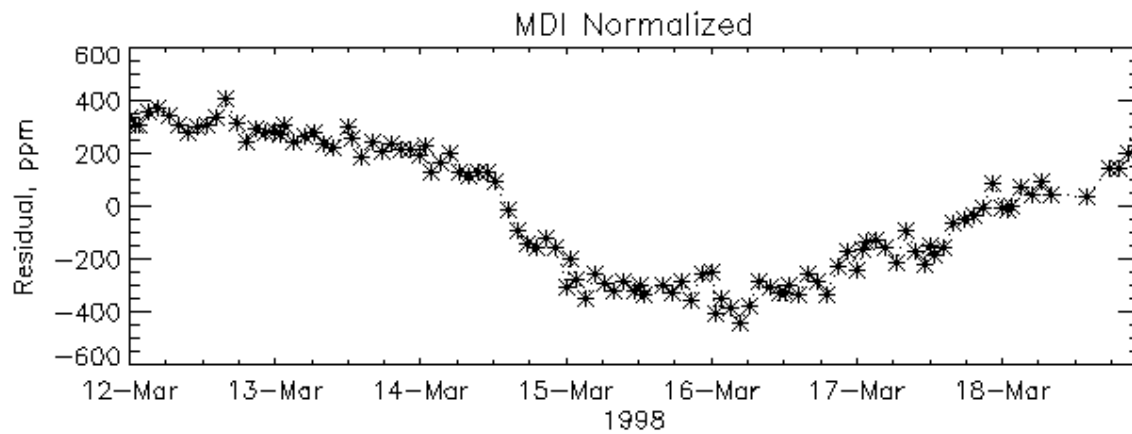
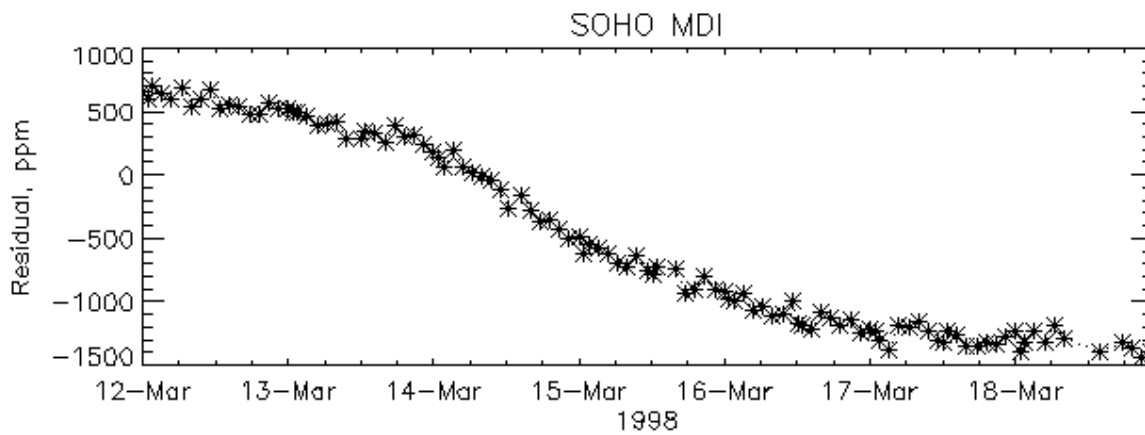
Growth phase



Rotation







Conclusion

- The physical growth of a sunspot group might result in a transient TSI effect
- The Spruit theory suggests that it might be small
- We haven't detected it in this analysis