What Have Measurements on the Archival Ca K Plates Taught Us About Solar Irradiance Variation?

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Topics

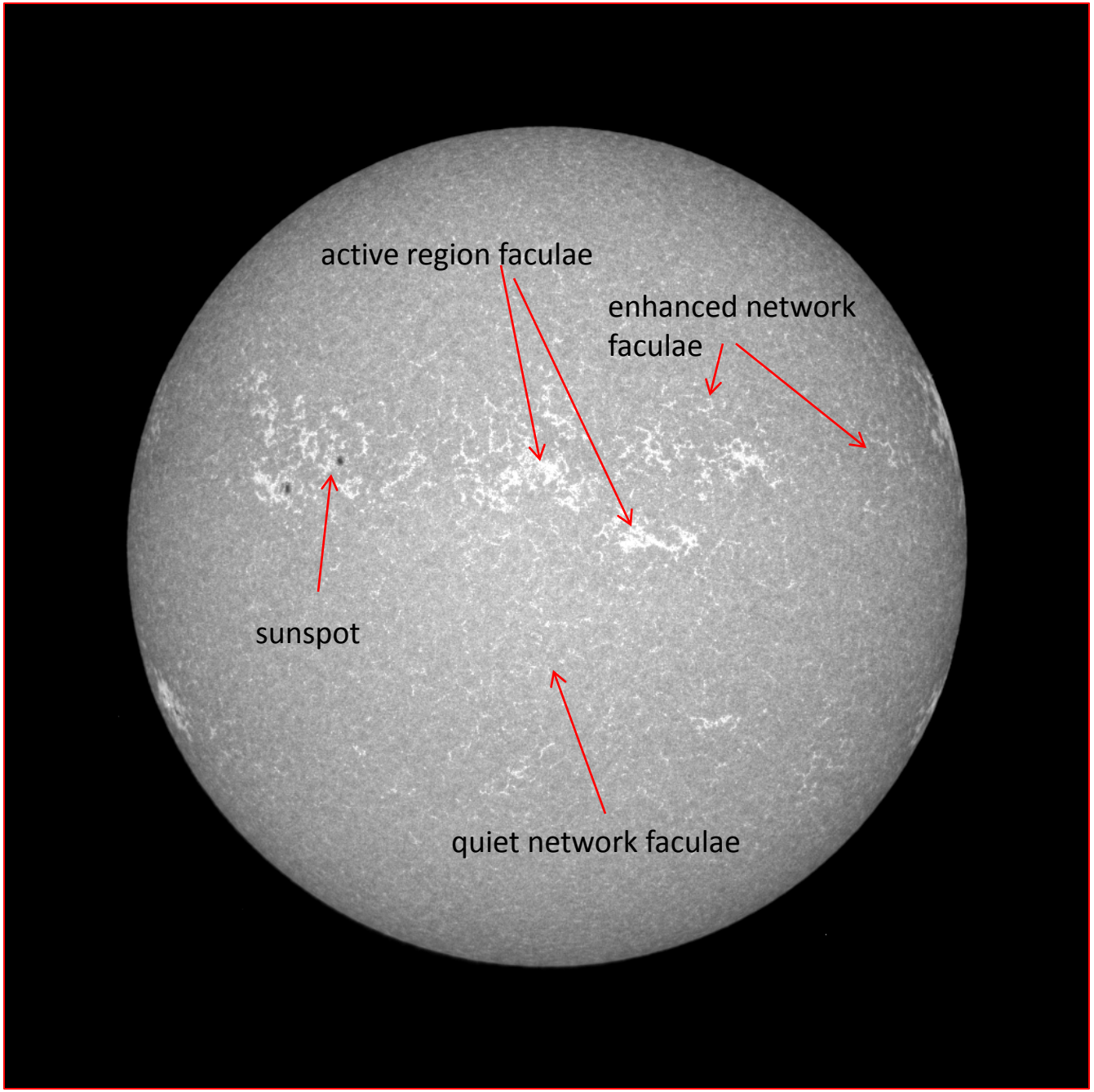
- How well can *post – 1980* TSI radiometry be reconstructed using Ca K facular areas?
- Comparison of the *pre-1980* TSI reconstructed from Ca K, SSN and F10.7.
- How do TSI and F_{uv} from Ca K compare with 20th century global temperatures?
- Are large irradiance variations claimed by e.g. Shapiro et al.(2011) compatible with Ca K evidence?

The magnetic structures that cause TSI variation:

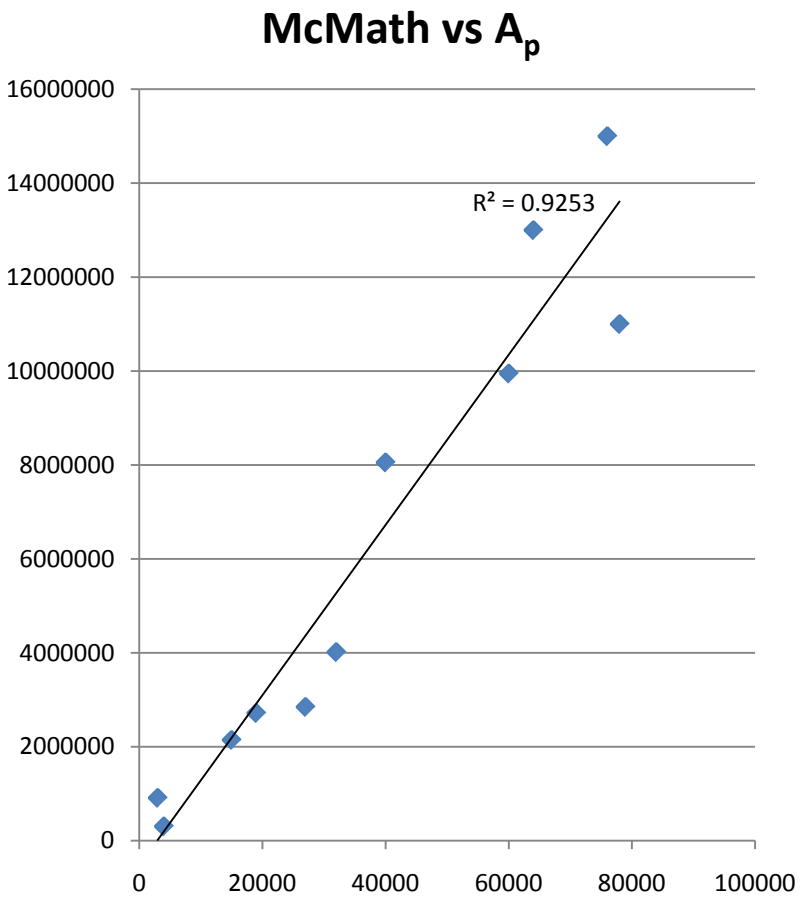
S**unspots** decrease TSI, **active region faculae** increase it, both on the solar rotational (27- day) time scale.

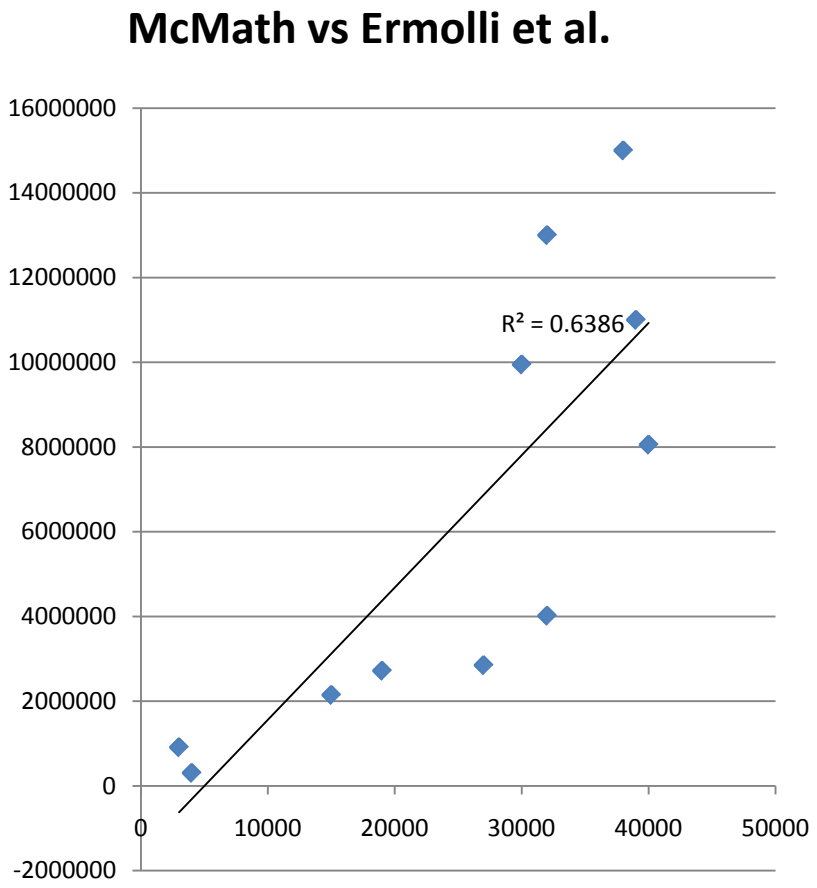
Brightening of Sun near 11 – yr activity maxima is caused mainly by increased area of **enhanced network faculae**

Depletion of **quiet network faculae** could cause an additional solar dimming during prolonged solar activity minima



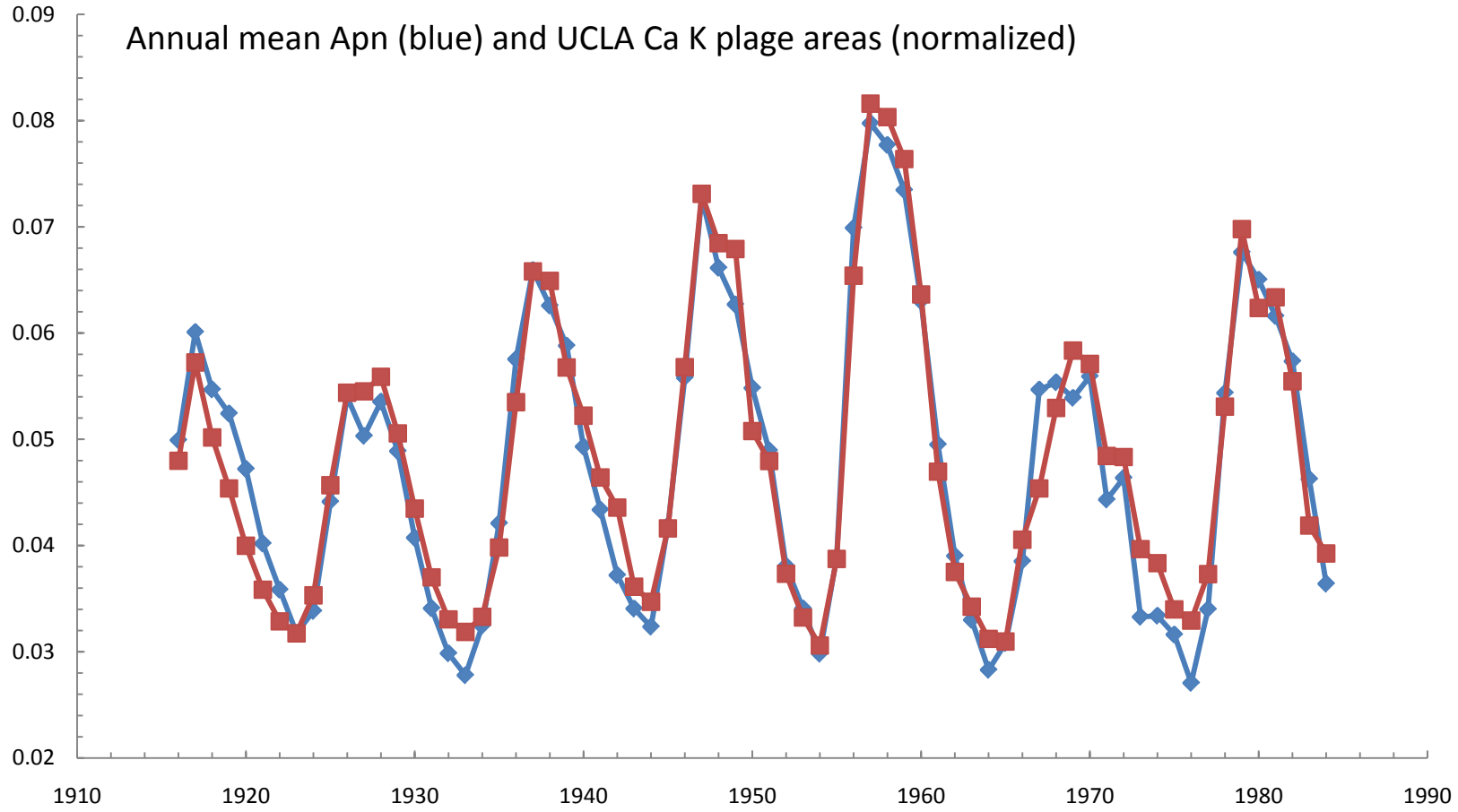
Cycle 19 disagreement of Ap with facular areas of Ermolli et al., 2009



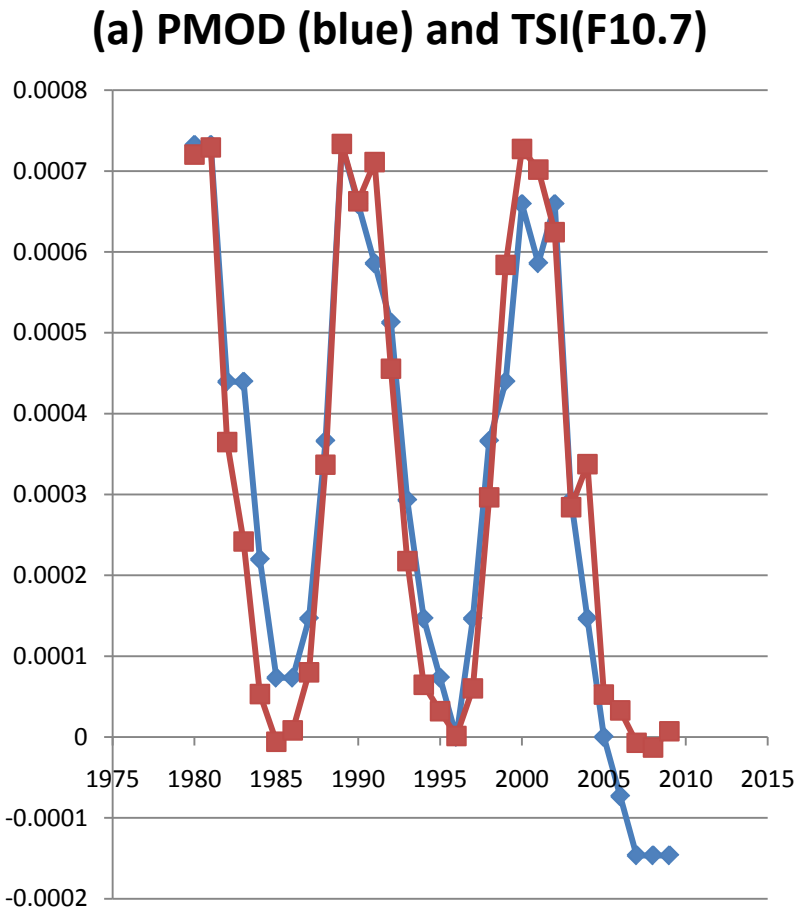


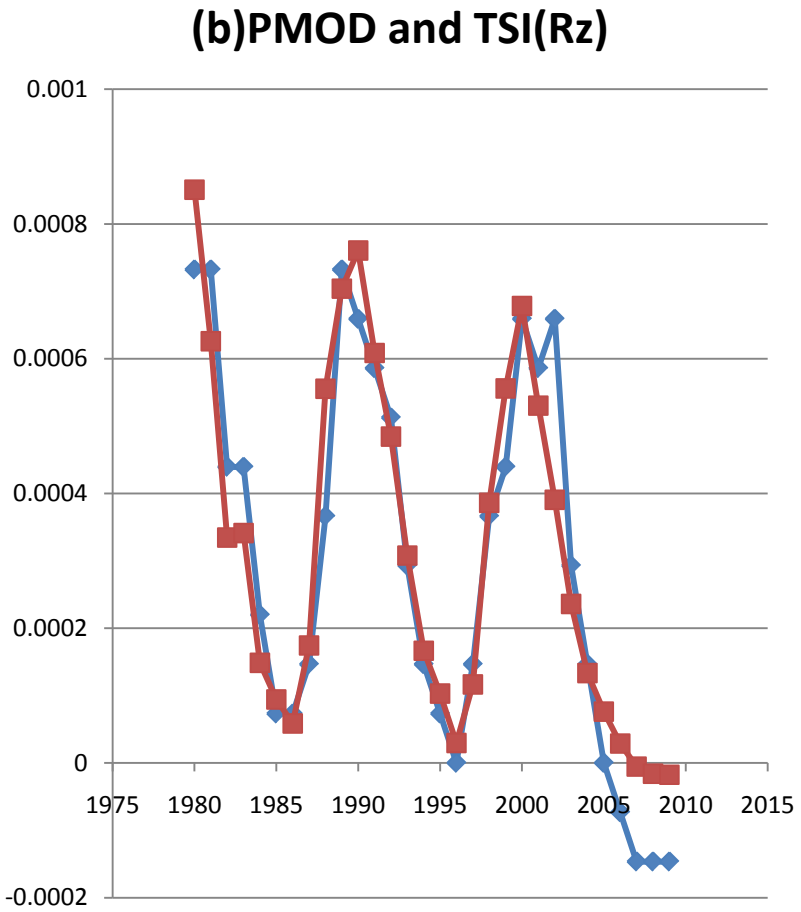
Main result of “CaK Summit” held at AGU in May, 2008:

Variation of Ca K (facular + network) areas *can* be measured reproducibly.



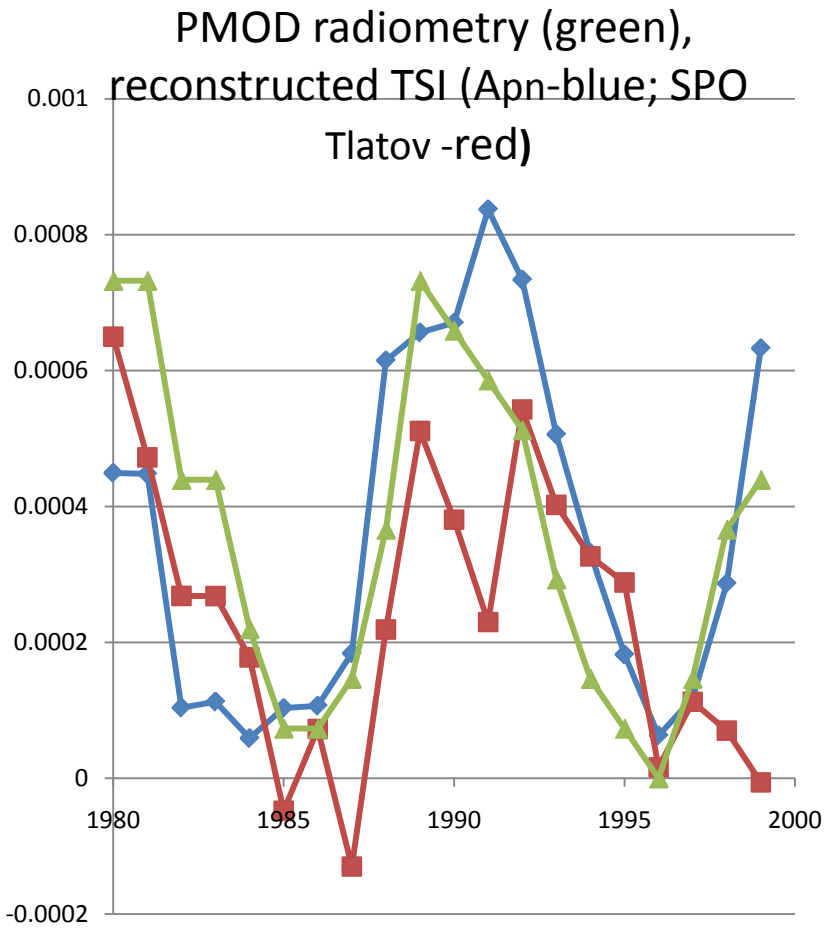
Reconstruction of TSI using F10.7 and SSN as proxies of the bright magnetic irradiance contribution



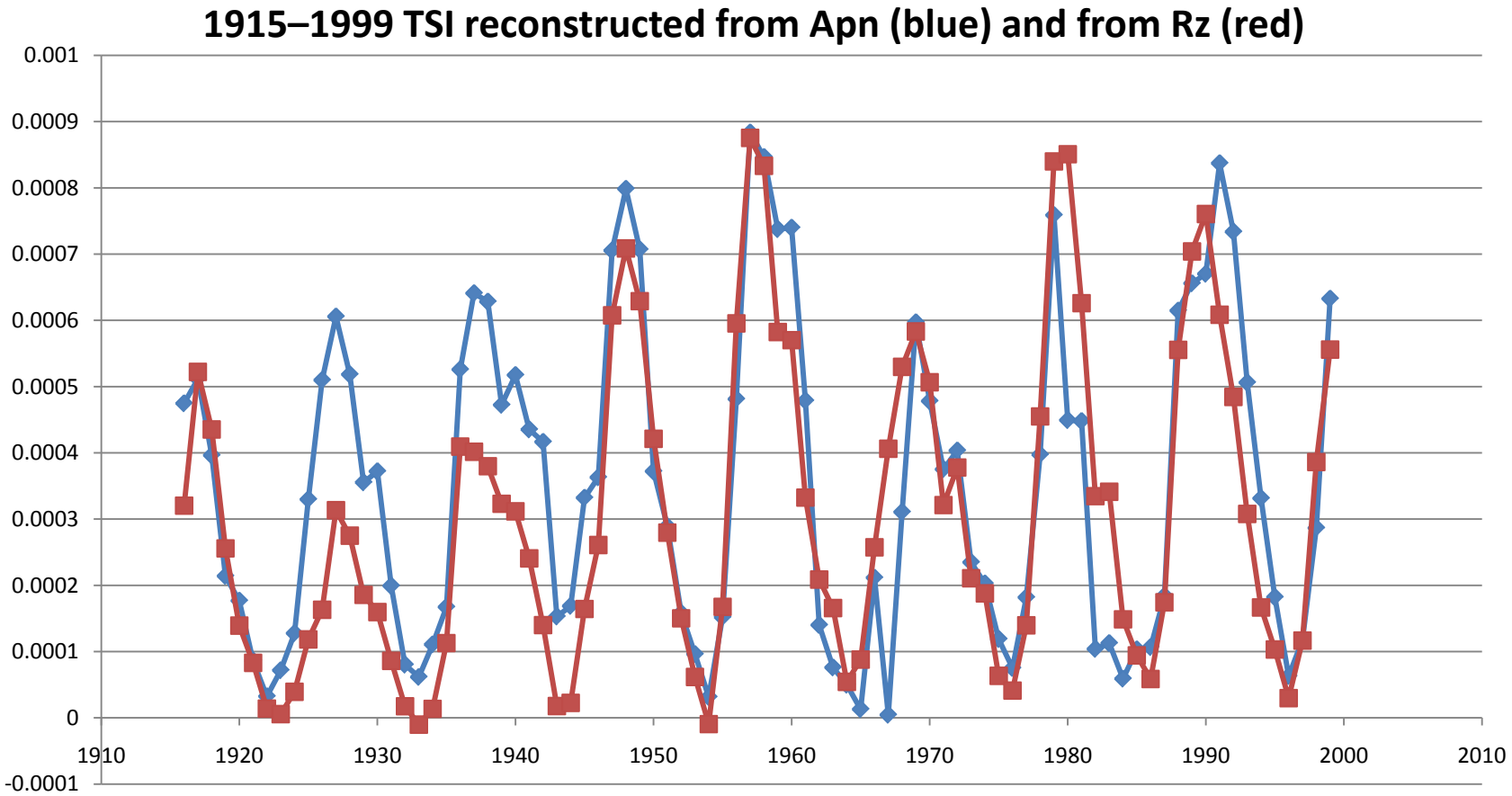


TSI reconstructed using Ca K facular areas

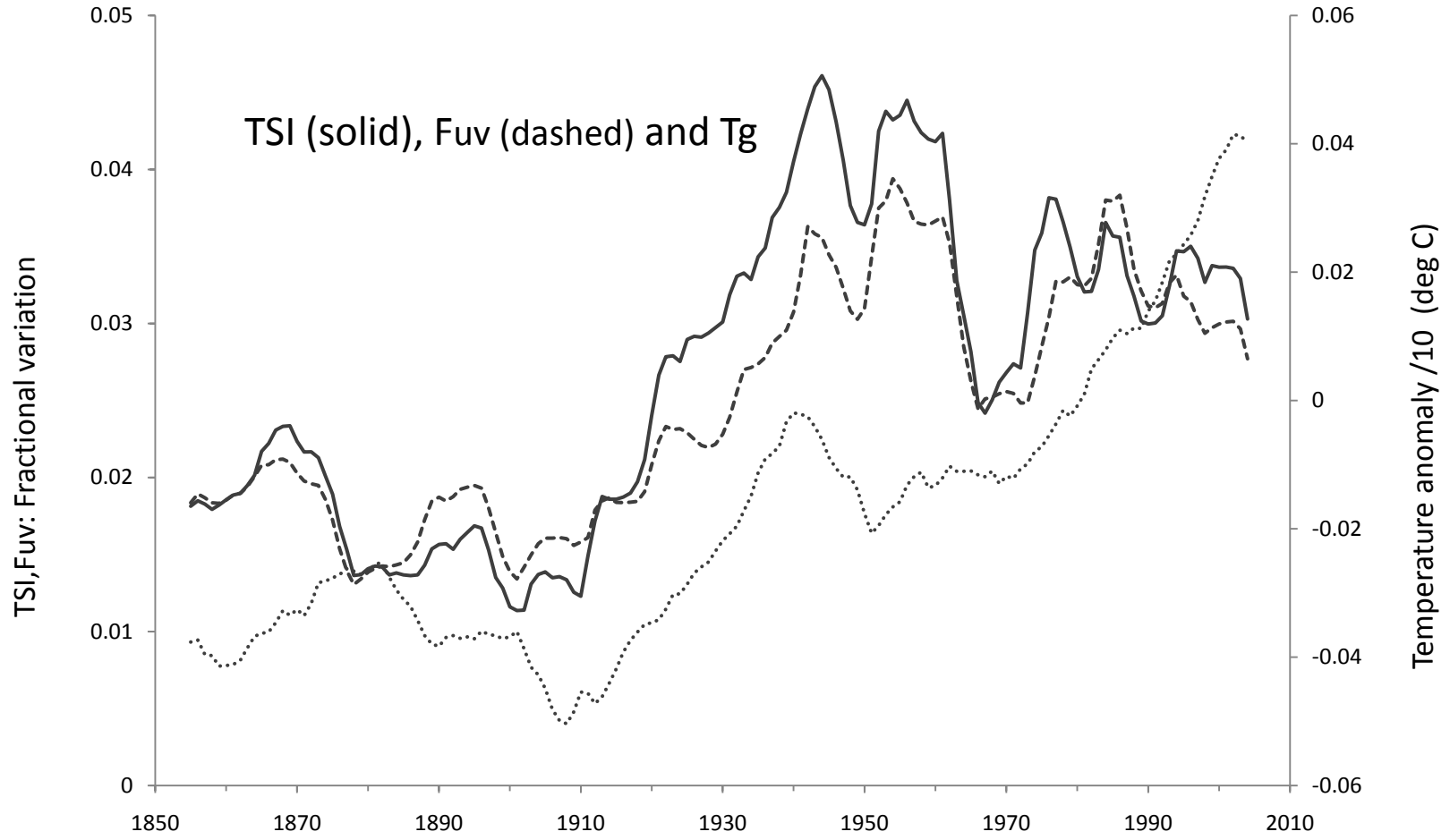
- Reconstruction from Ca K plage areas is *less successful* than from indirect proxies such as SSN and F10.7.
- The post – 1984 areas are based on independent digitizations and measurement of *SPO* plates by CRI and Pulkovo
- These areas are less reproducible than the *MWO* areas measured by CRI, UCLA and Pulkovo.



The (SSN – based) IPCC TSI values are 30-50% lower than Ca K – based TSI during cycles 16, 17.

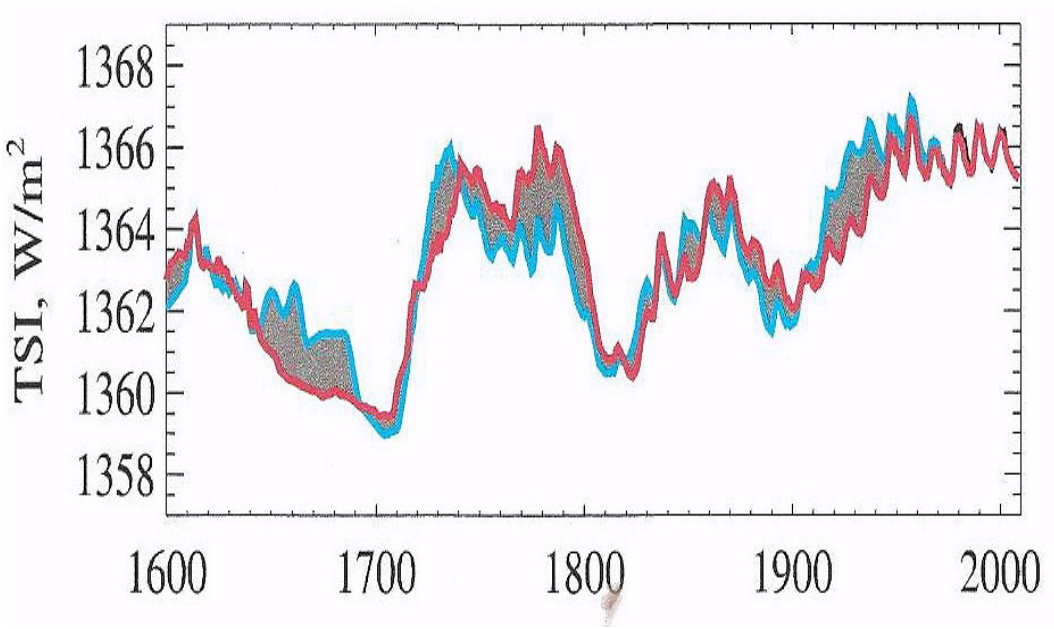


The mid- 20th century irradiance maximum extends *20 yrs* beyond onset of global cooling around 1940.

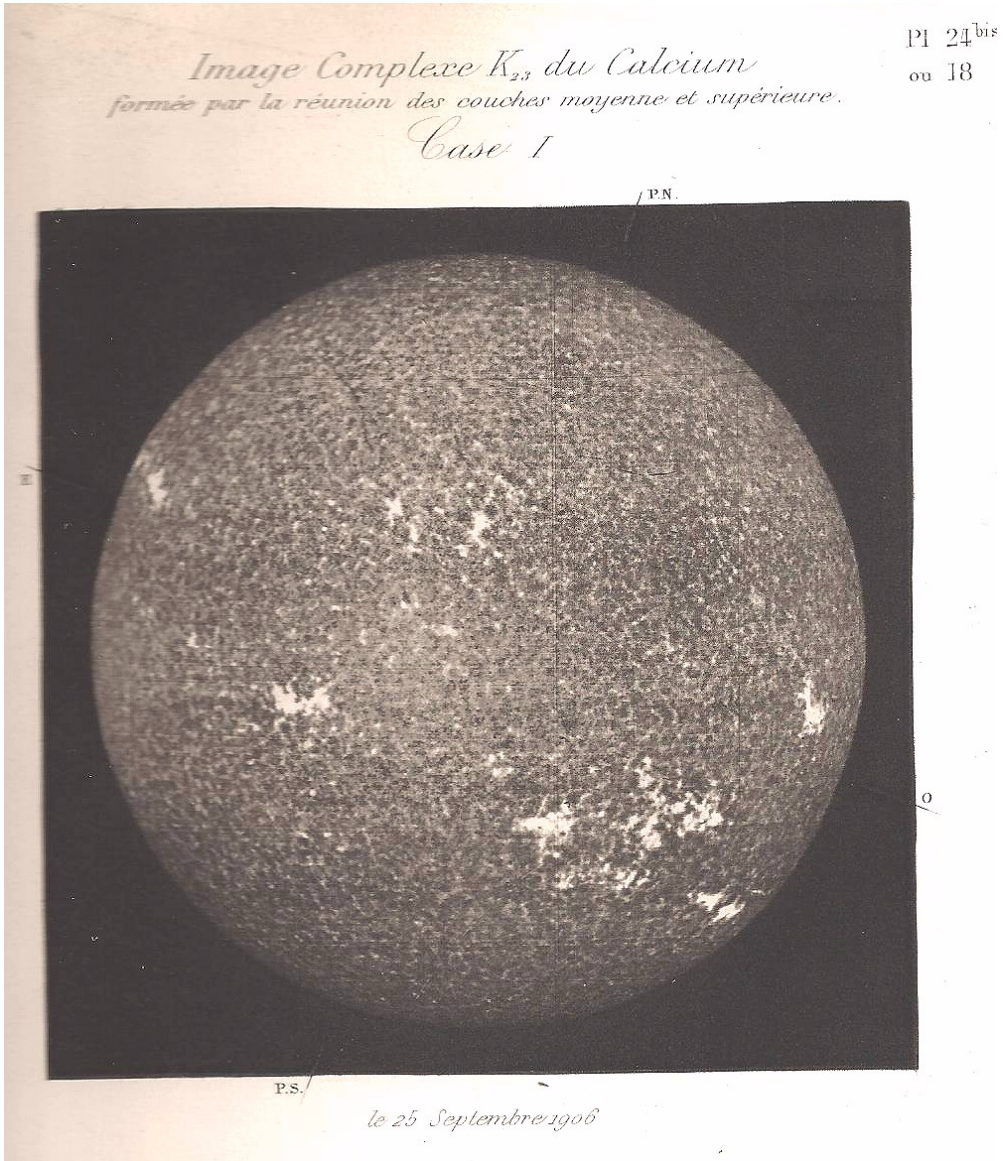


Shapiro et al. 2011 claim large (~0.3%) 20th century solar brightening

- Ascribed to increase of network/internetwork 1900-present
- But network/internetwork TSI contribution ~ 0.15%
- So requires *complete disappearance* of network/internetwork around 1900
- This contradicts Ca K record of fully-formed network from 1890's-present



The chromospheric network was *not* absent on Sept 25, 1906



No detectable network area change over nine activity minima between 1913 – 1996 (Foukal & Milano,2001)

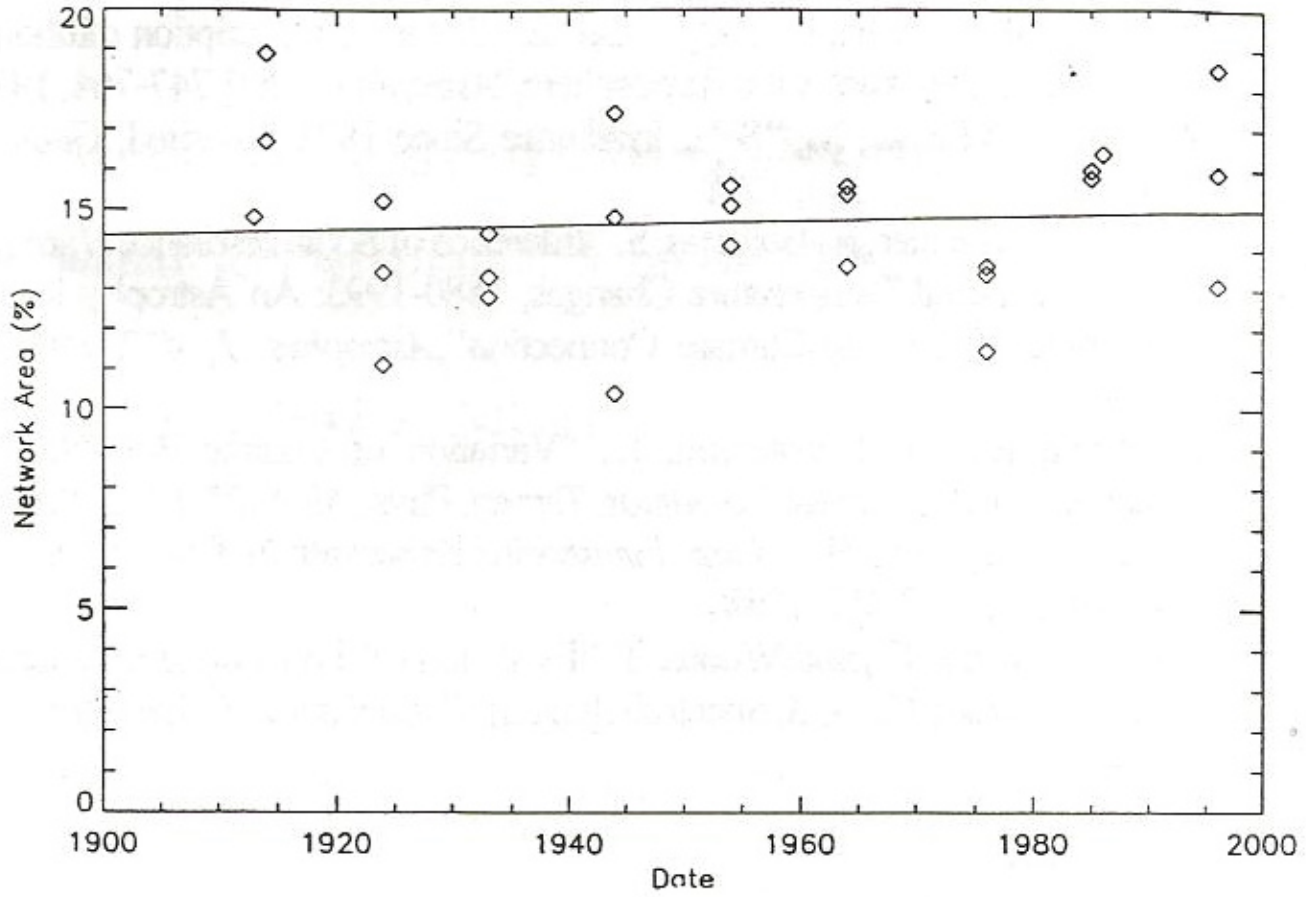


Figure 3. Plot of quiet network area (% of projected disc) at each minimum, versus date. The solid line shows a linear least squares fit.

Conclusions

- The A_{pn}, UCLA and Pulkovo facular areas from the 1915 – 1984 MWO plates behave similarly.
- TSI reconstructed using these Ca K areas agrees with TSI from SSN used by the IPCC for most of 1915- 1984. *But cycles 16 and 17 are 30-50% higher.*
- Areas from the SPO plates, and cycles 18,19 from Kodaikanal, exhibit disagreements we still do not understand.
- The mid- 20th century peak of TSI and UV flux extends *20 years* beyond the onset of post–1940 cooling. This correlation failure limits the contribution of irradiance variation to 20th century climate change.
- Significant 20th century solar brightening claimed by Shapiro et al. requires *disappearance* of the network/ inter-network during this period. The presence of fully formed Ca K network since the 1890's calls into question the validity of this model throughout the Holocene.