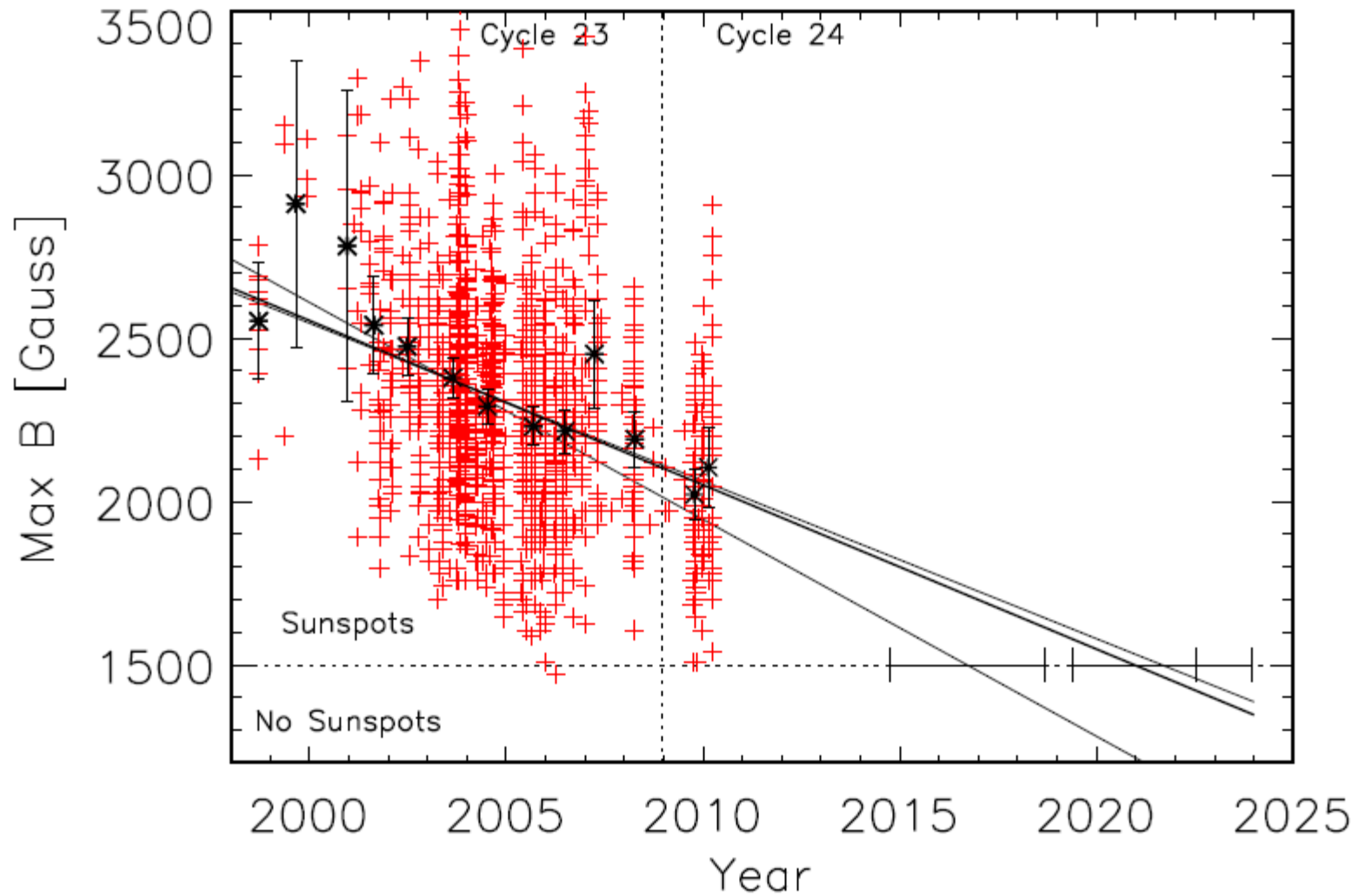


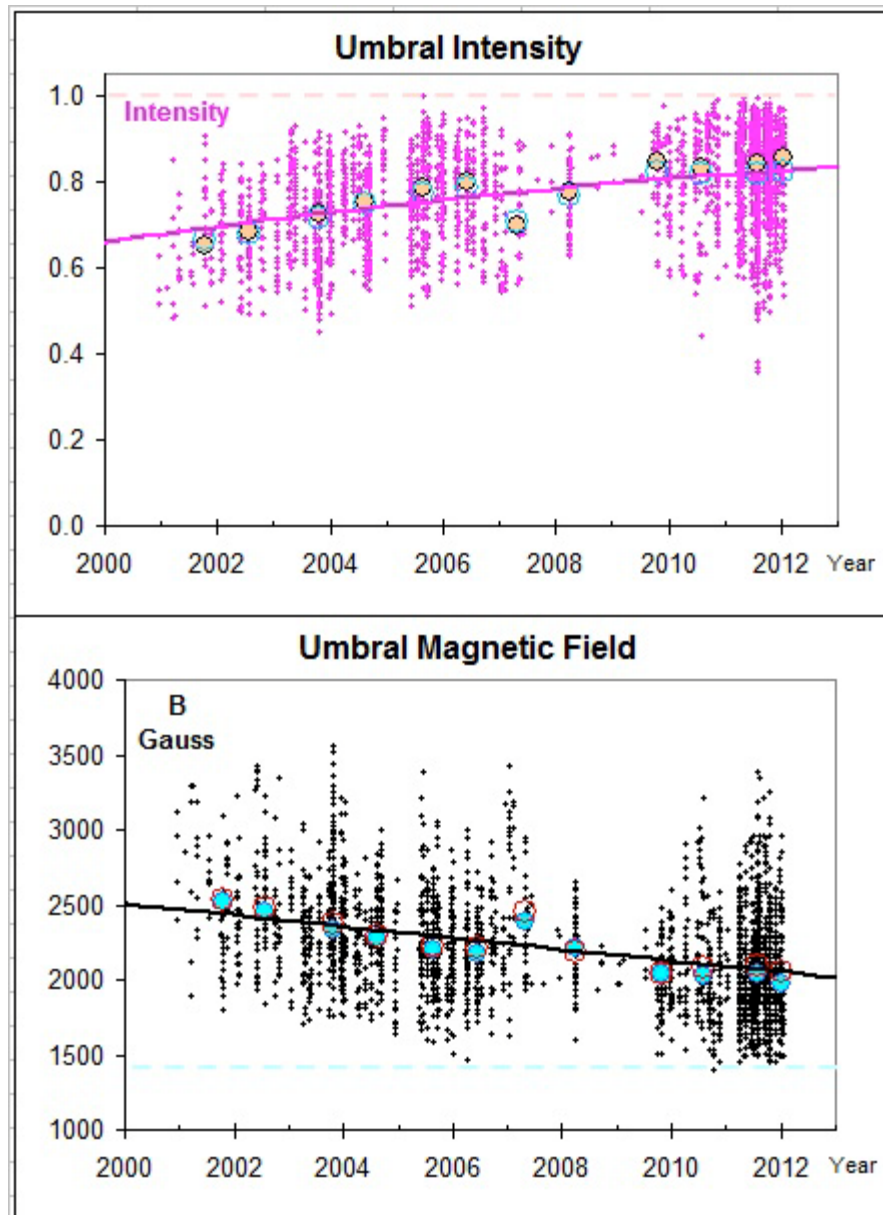
Sunspot Magnetic Fields and umbral areas in Cycles 15-19

A. A. Pevtsov (NSO)

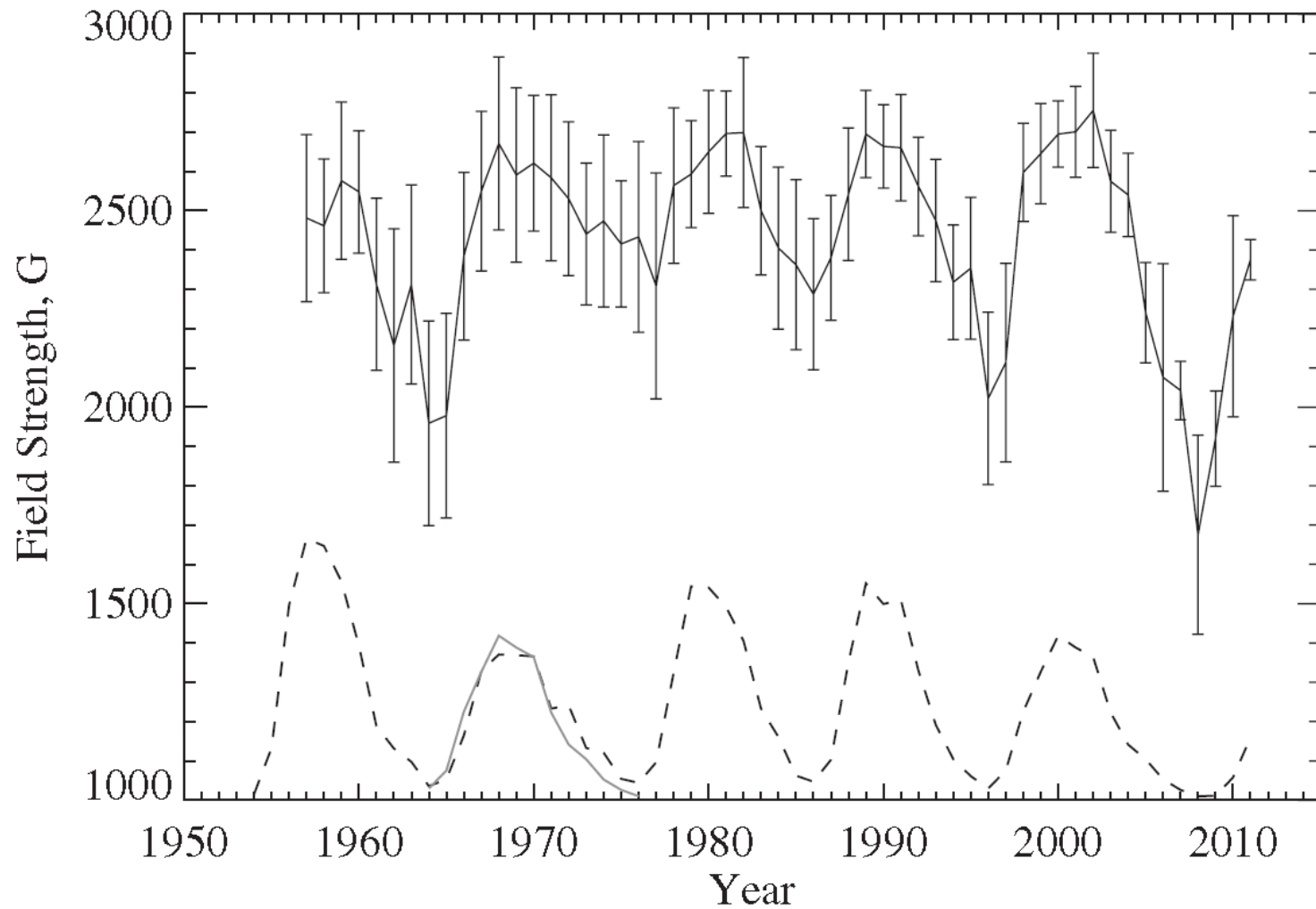
Co-Authors: L. Bertello, A. Tlatov, A. Kilcik, Yu. Nagovitsyn, E. Cliver



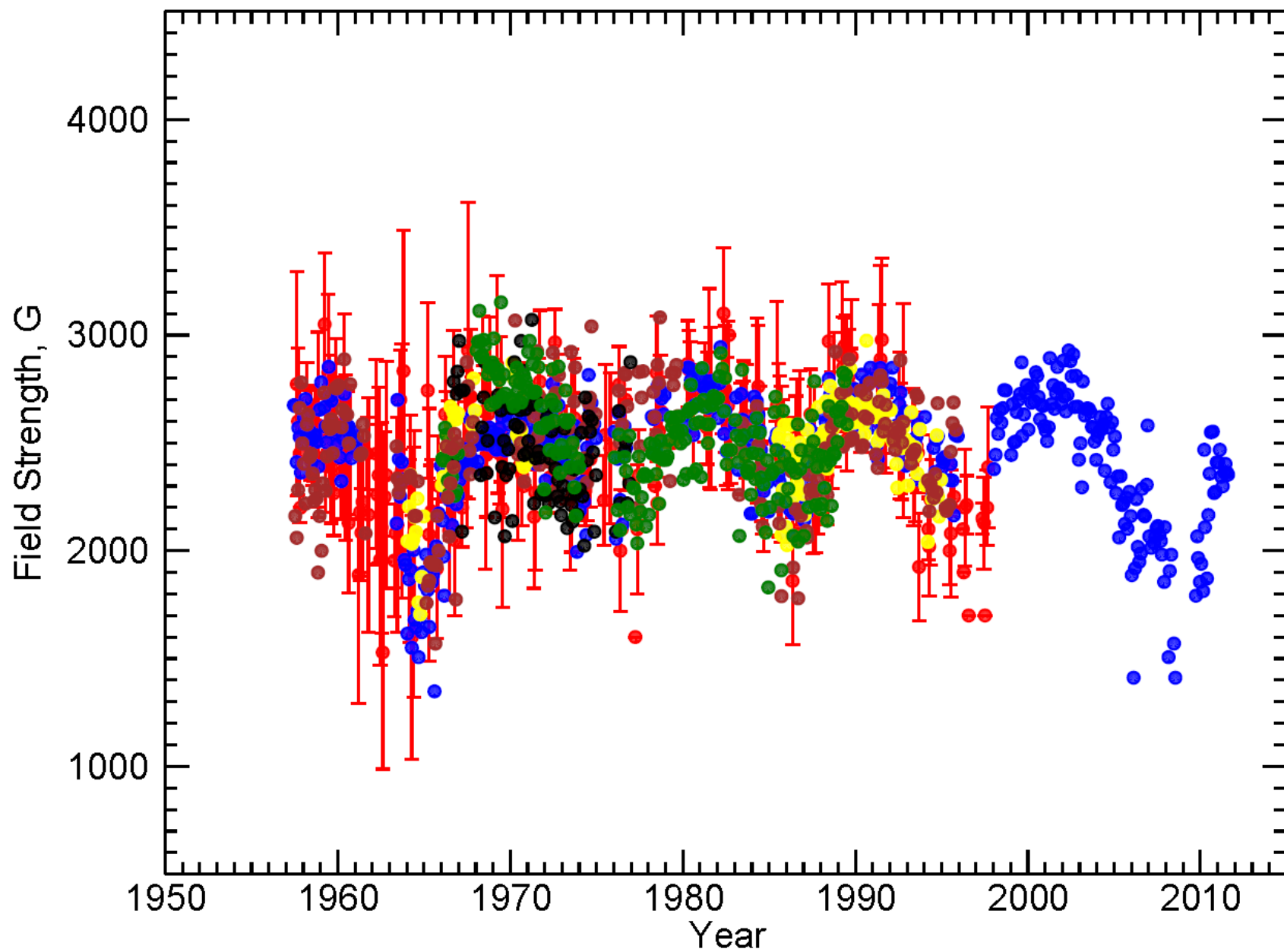
Penn and Livingston, 2011



Livingston (private communication)



Pevtsov et al. 2011 (Mag. field measurements from 7 stations)

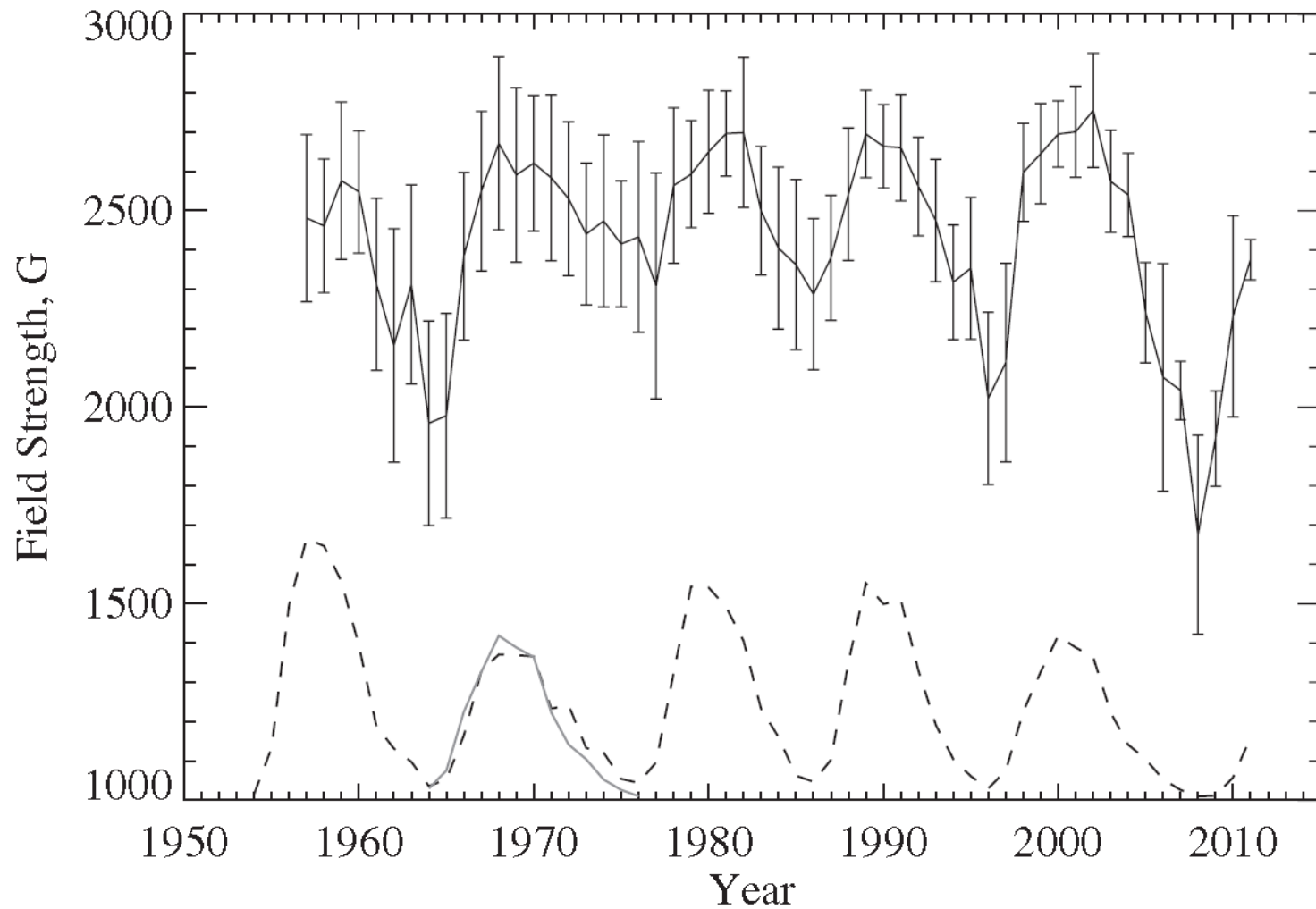


Observatories of the former USSR

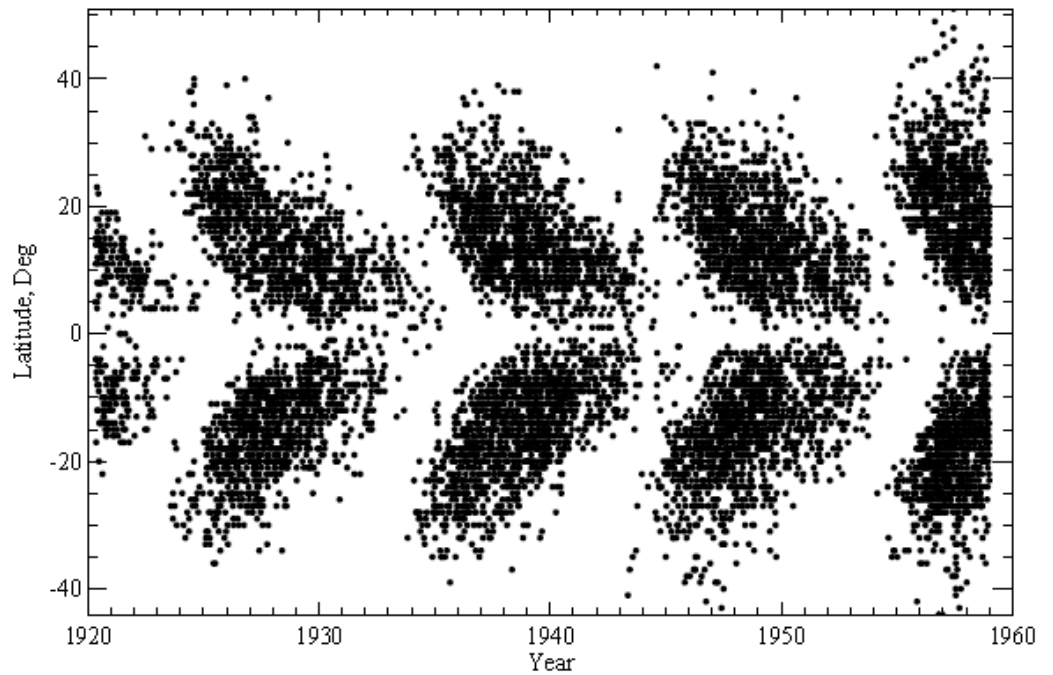
Crimean
observatory
(CRAO):
continuation of
USSR sunspot MF
strength obs.
program in
1998-2012

<http://swc.crao.crimea.ua>



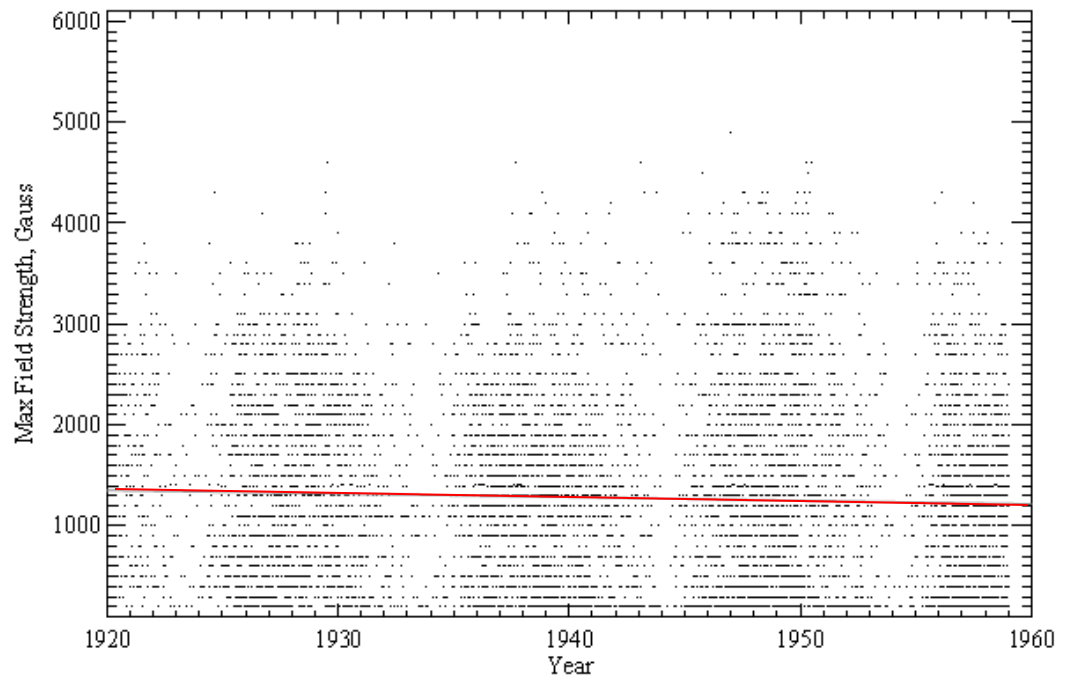


Pevtsov et al. 2011 (Mag. field measurements from 7 stations)



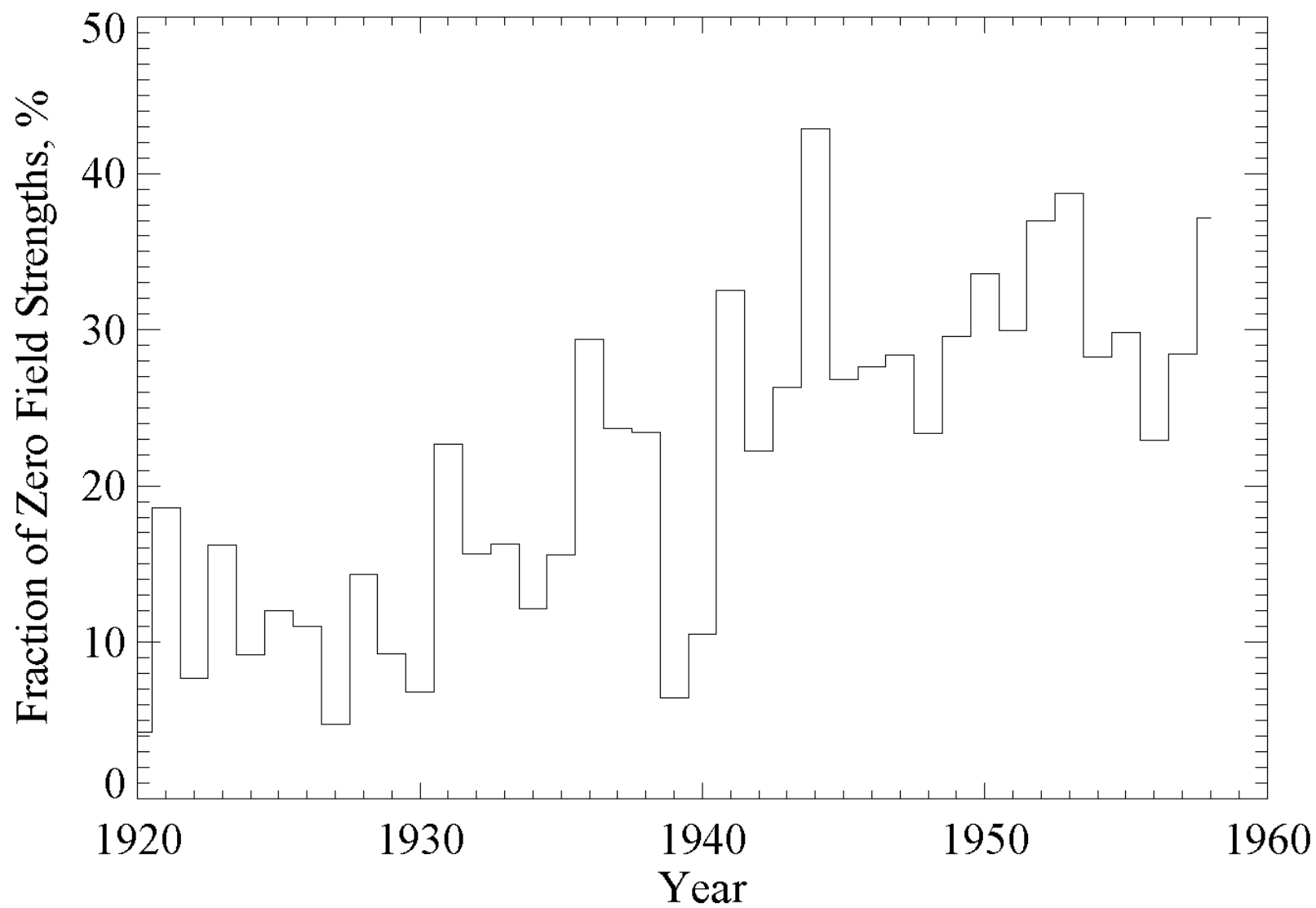
$$B = (22995 \pm 1547) + (-11.3 \pm 0.8) \cdot Yr$$

All: Decrease of 452 G in 40 yr

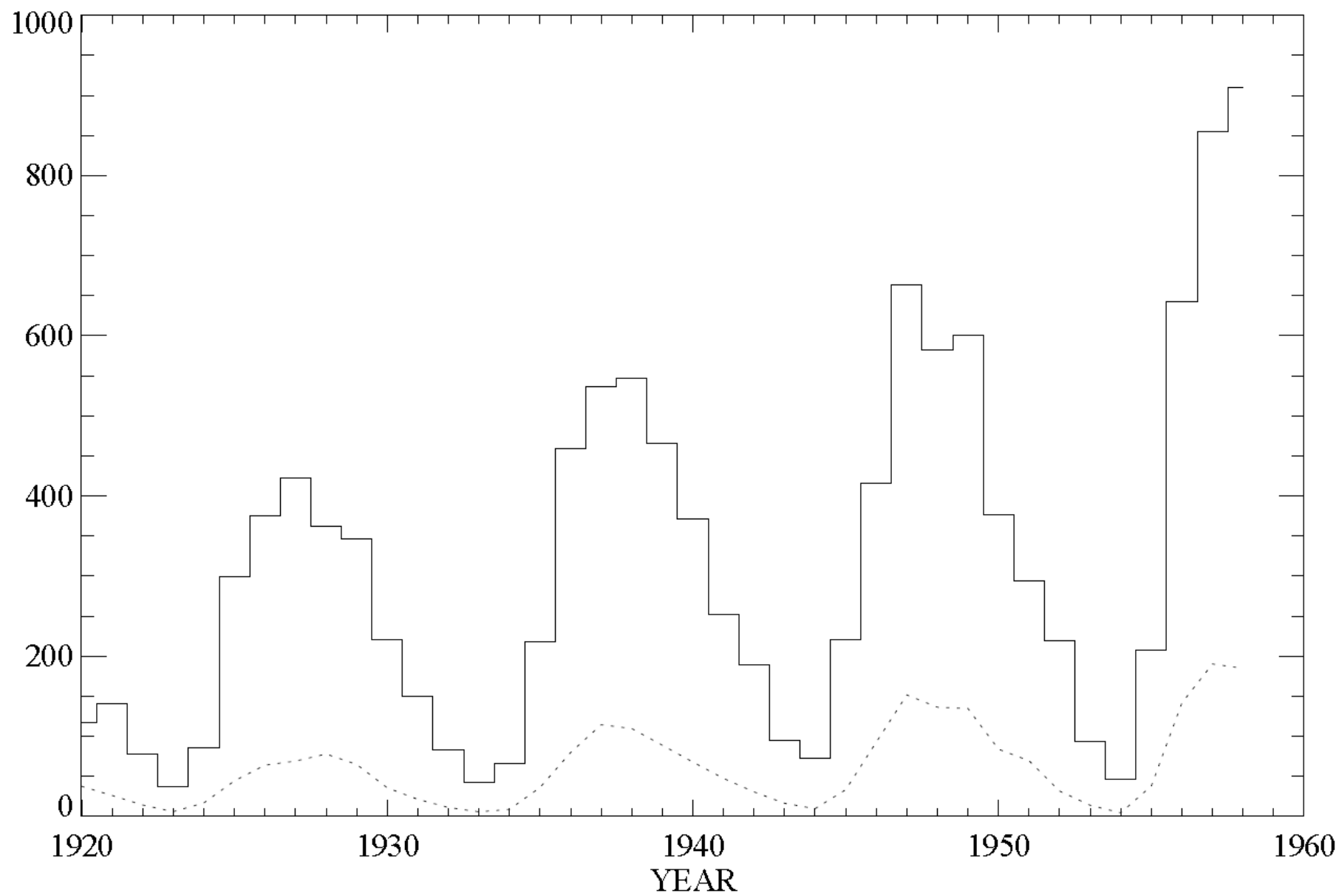


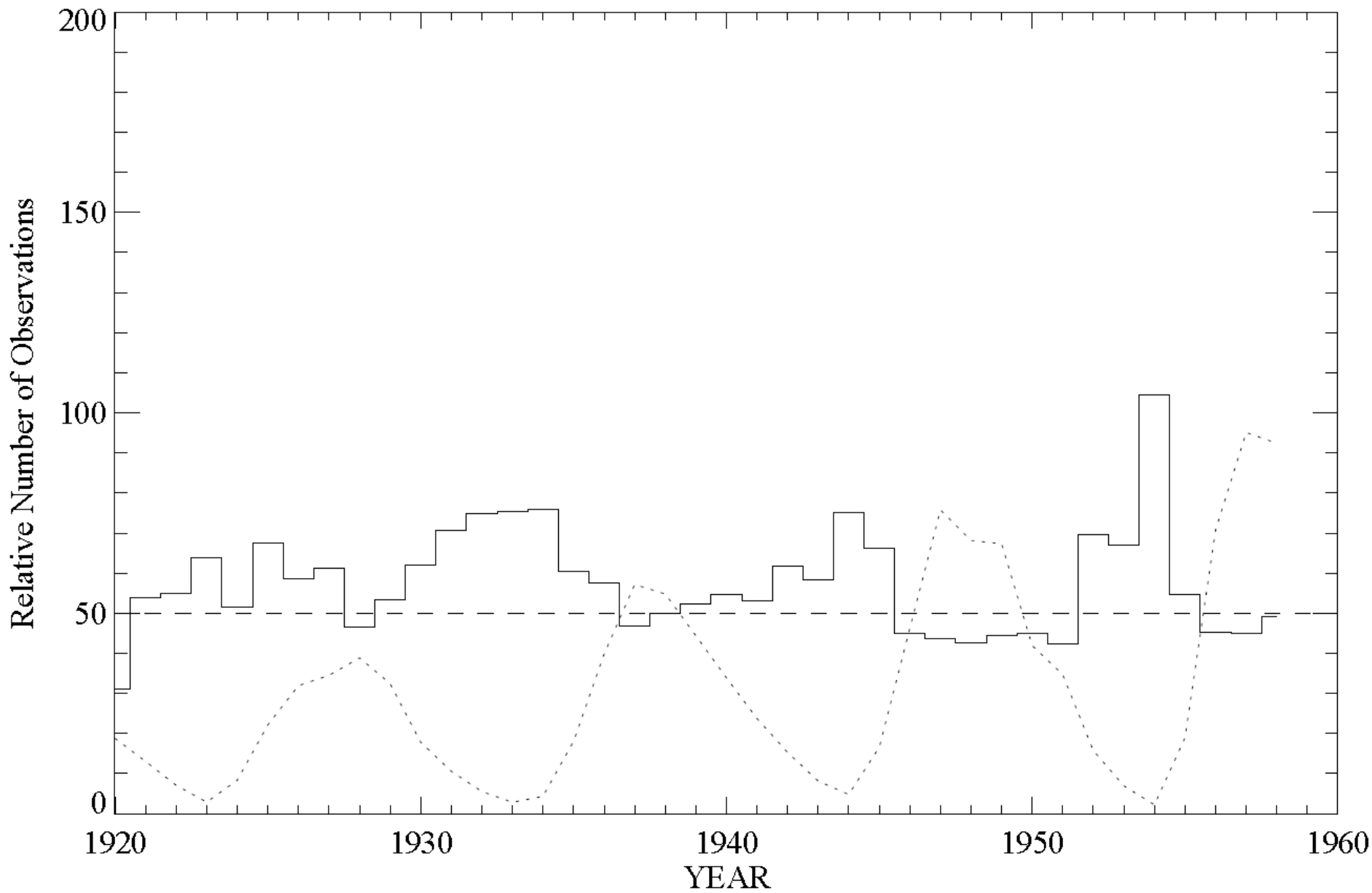
$$B = (7897 \pm 1665) + (-3.4 \pm 0.9) \cdot Yr$$

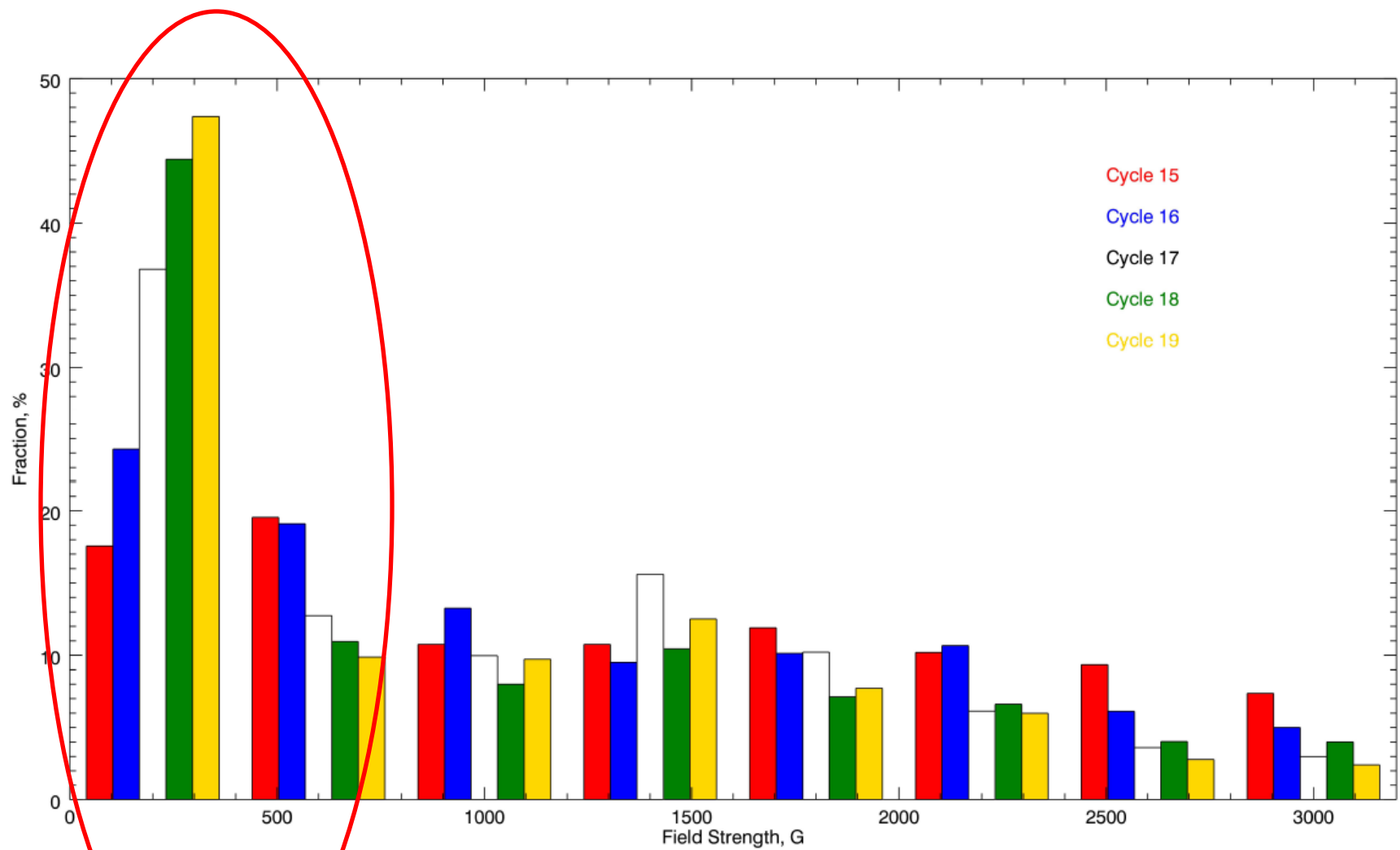
Non-zero: decrease of 136 G in 40 yr

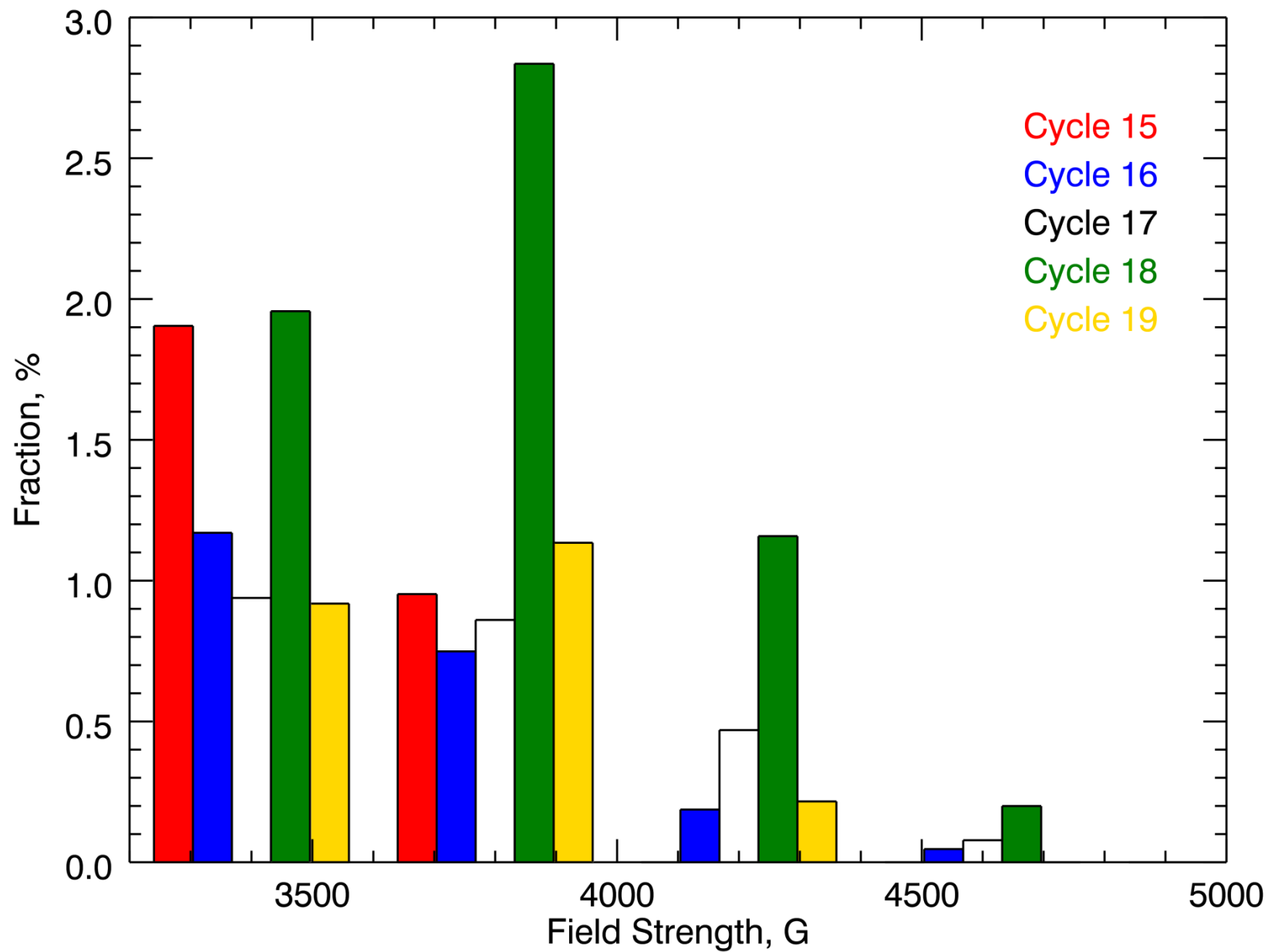


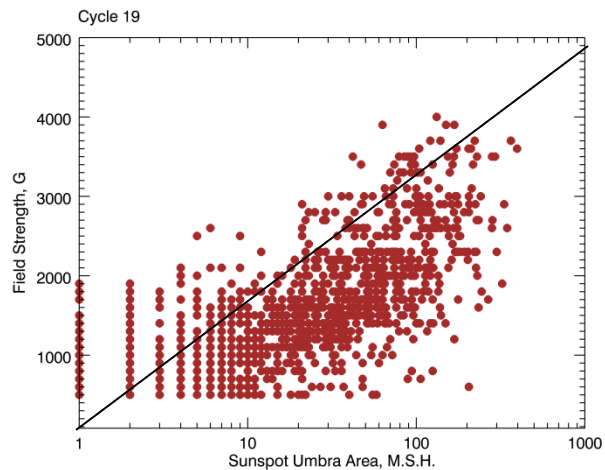
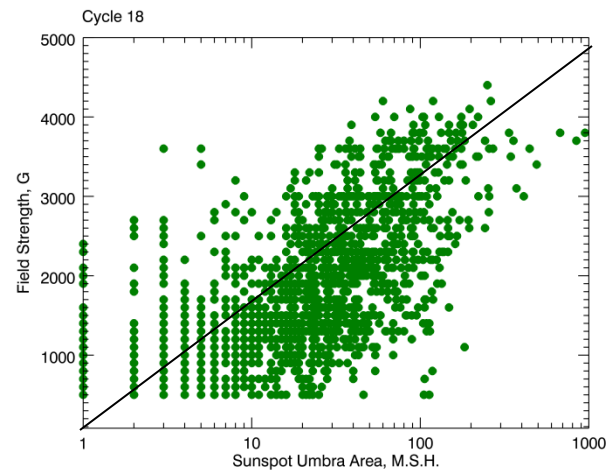
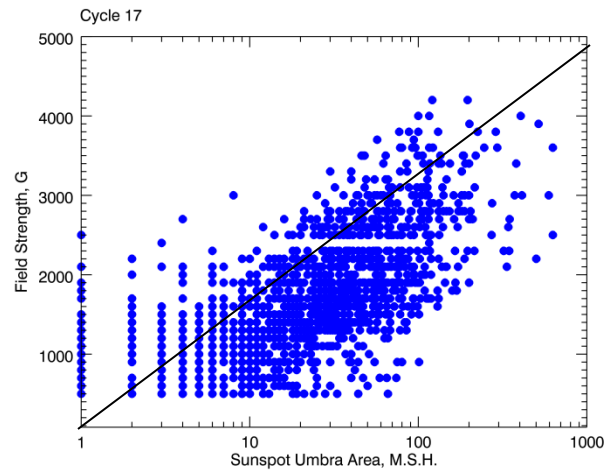
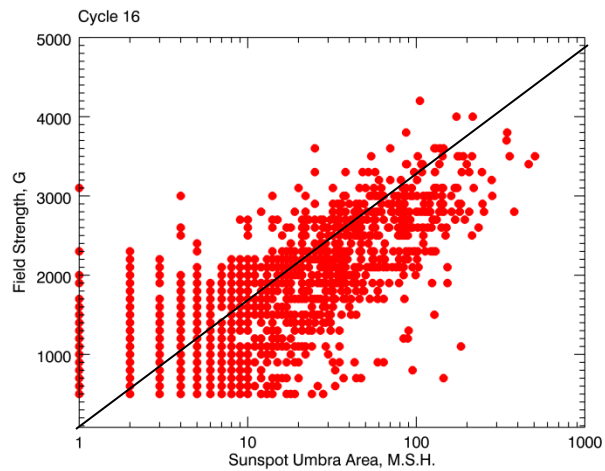
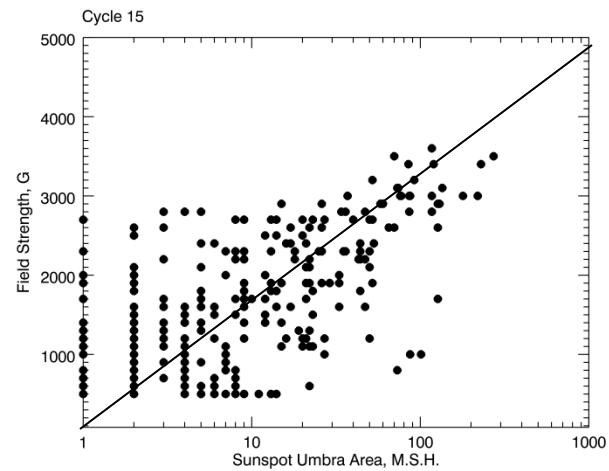
Number of Observations





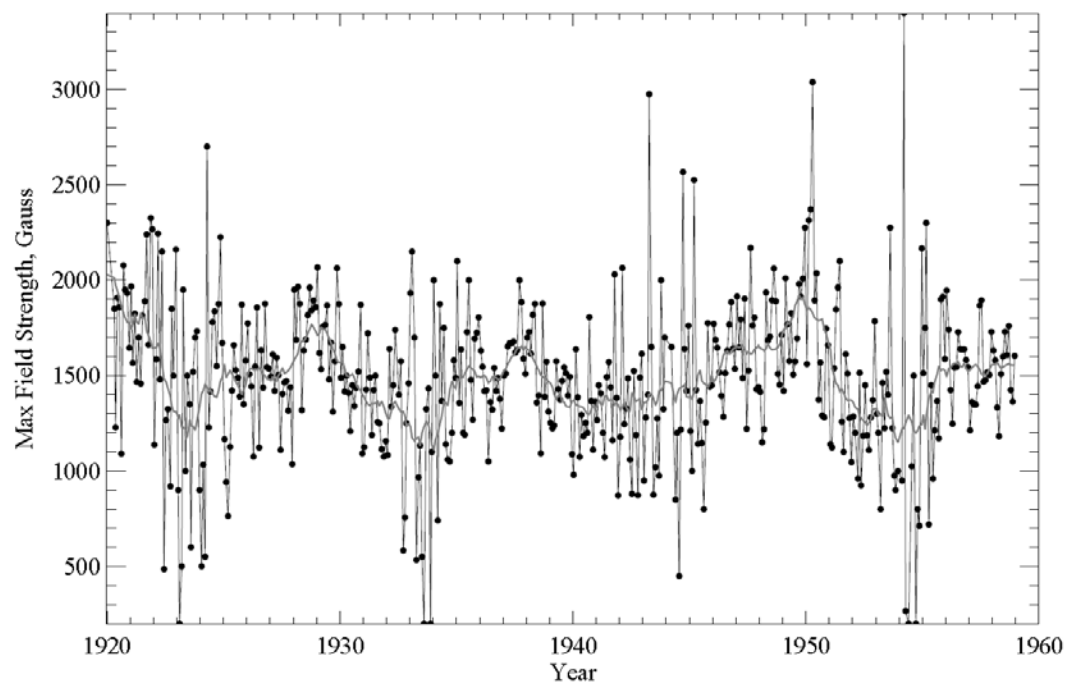
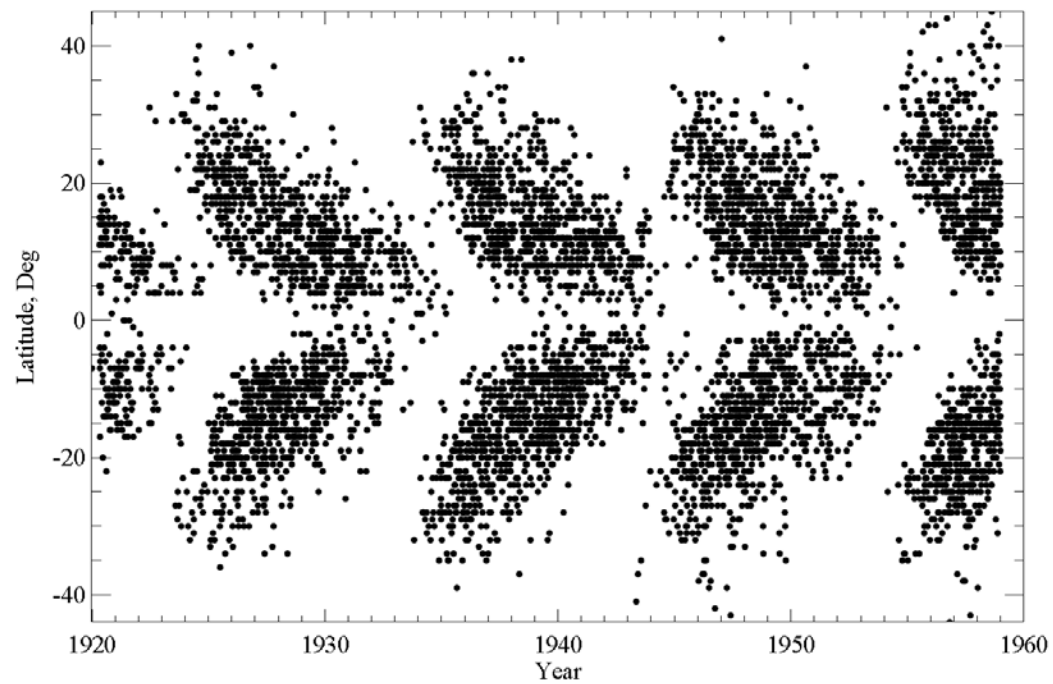


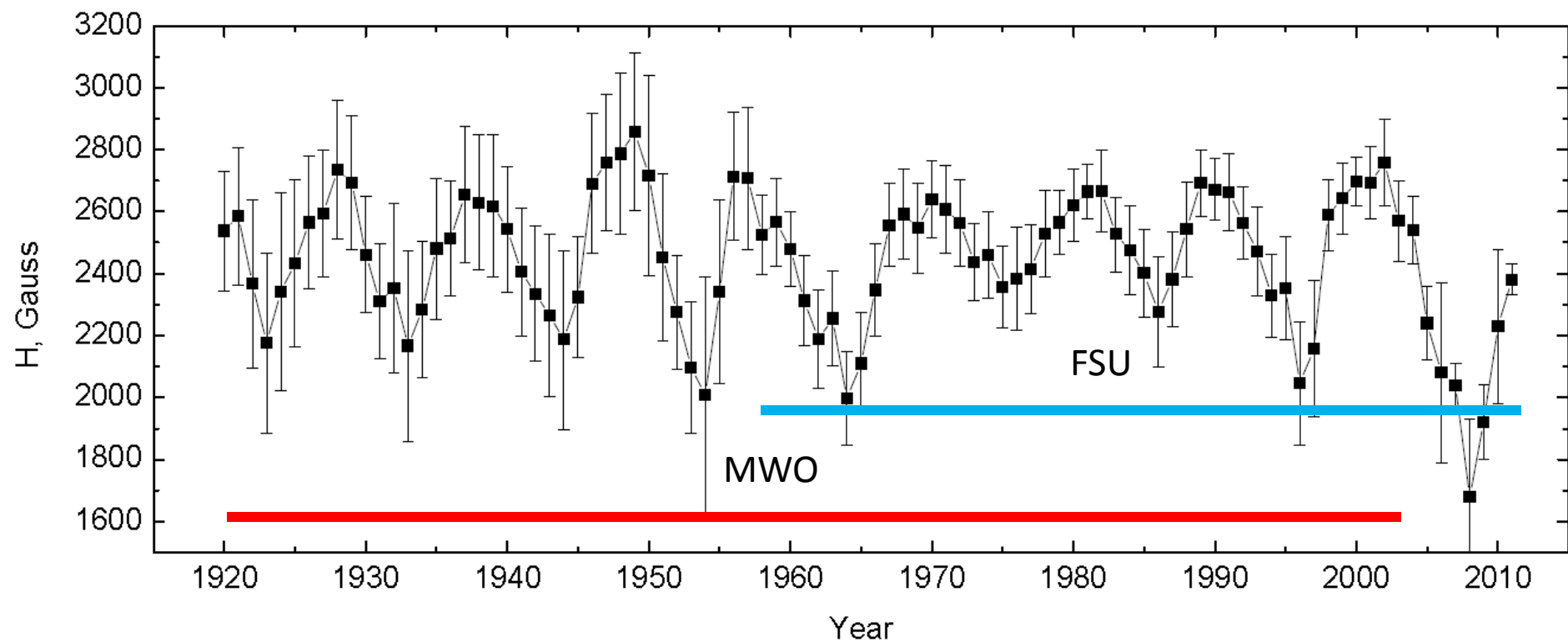




$$H = A + B \log_{10} \text{Area}$$

Cycle 15	2.63+/-0.04	0.31+/-0.02	0.76
Cycle 16	2.57+/-0.01	0.33+/-0.01	0.74
Cycle 17	2.40+/-0.02	0.36+/-0.01	0.66
Cycle 18	1.97+/-0.02	0.54+/-0.01	0.76
Cycle 19	2.08+/-0.02	0.47+/-0.01	0.79





$$FSU(1958-1985) = (0.511 \pm 0.059)MWO + (1490 \pm 110), \rho = 0.800$$

$$FSU(1985-2001) = (1.02 \pm 0.14)MWO + (150 \pm 330), \rho = 0.900$$

Conclusions

- (1920-1958) MWO sunspot measurements show systematic increase in zero field strengths
- MWO data show systematic increase in fraction of 100-400 G fields and decrease in 400-800G fields. All other ranges of field strength do not show any systematic variations.
- Cycle 18 exhibits larger fraction of strongest fields (3000+ Gauss)
- When all measurements are averaged, the data show long-term trend (450 G per 40 years).
- When only strong fields are selected (strongest field strength per observing day), the data show cycle variations only.
- MWO and FSU data correlate well with each other. Combined data set does not show systematic long-term trend.
- **No Livingston-Penn decline in field strengths in MWO data!**