Asymmetric Solar Polar Field Reversals

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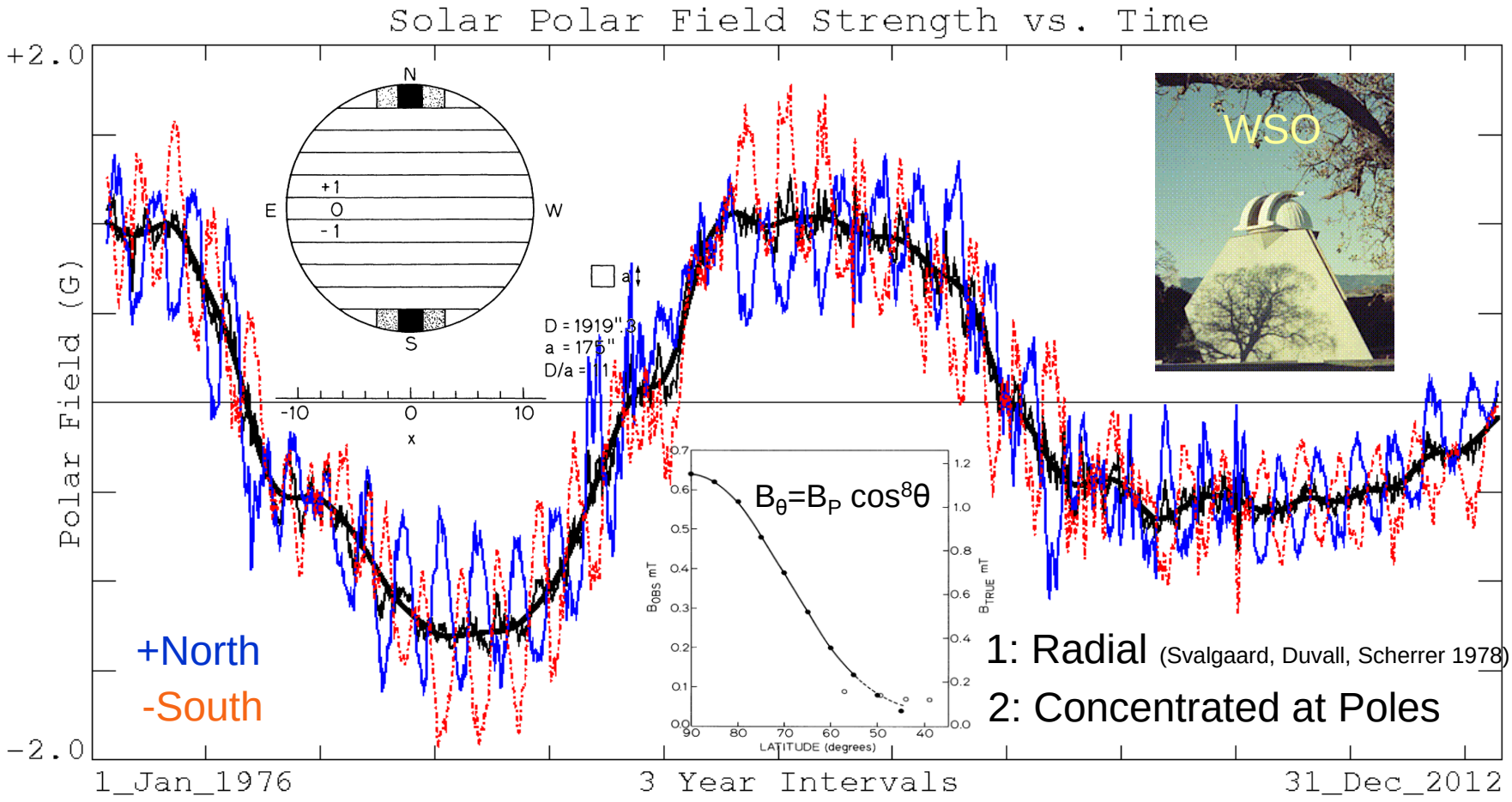
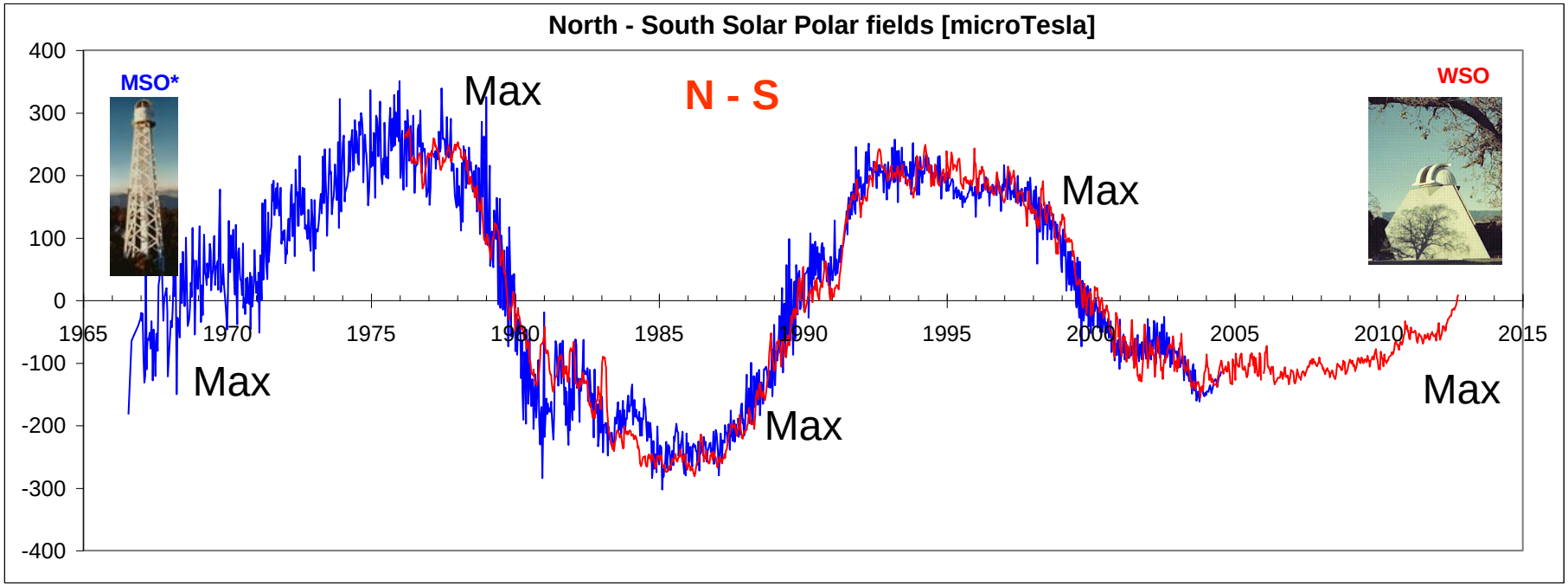
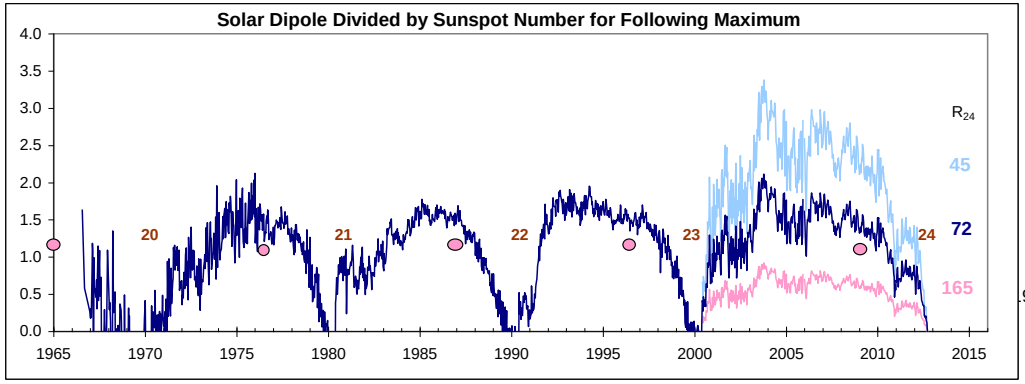
AGU Fall Meeting, SH12A-07, 3 Dec. 2012

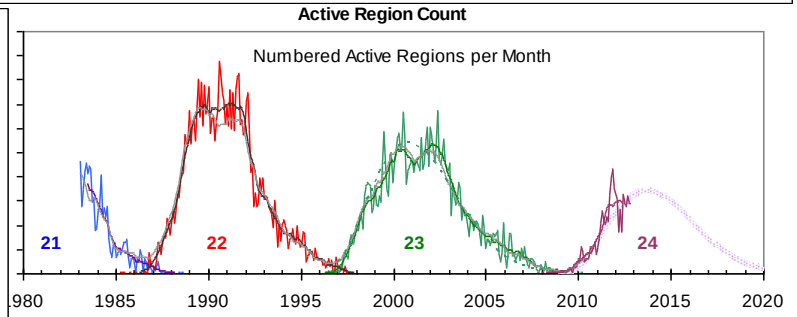
Observing the Polar Flux



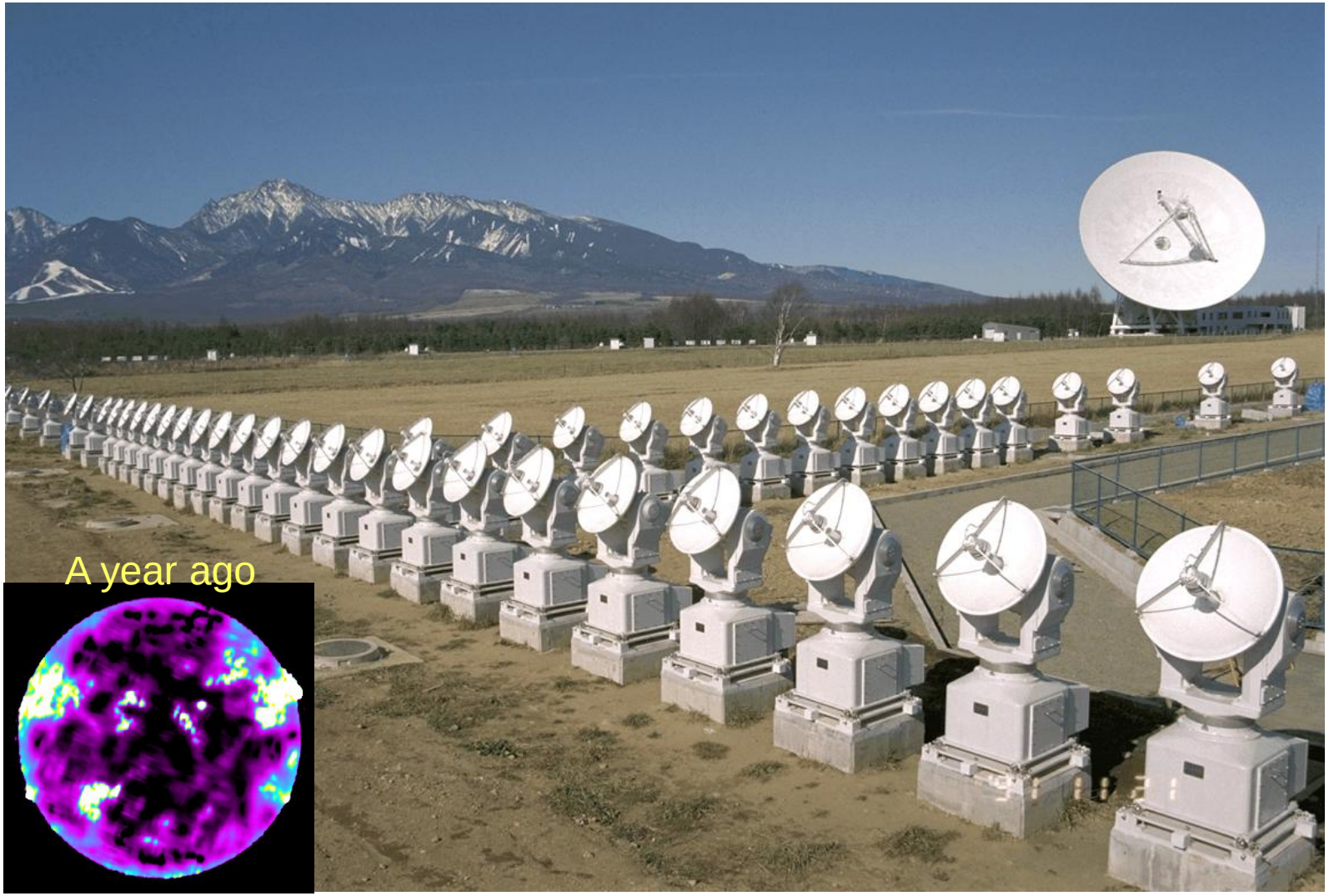
“Dipole Moment” seems to be a Predictor of the Solar Cycle



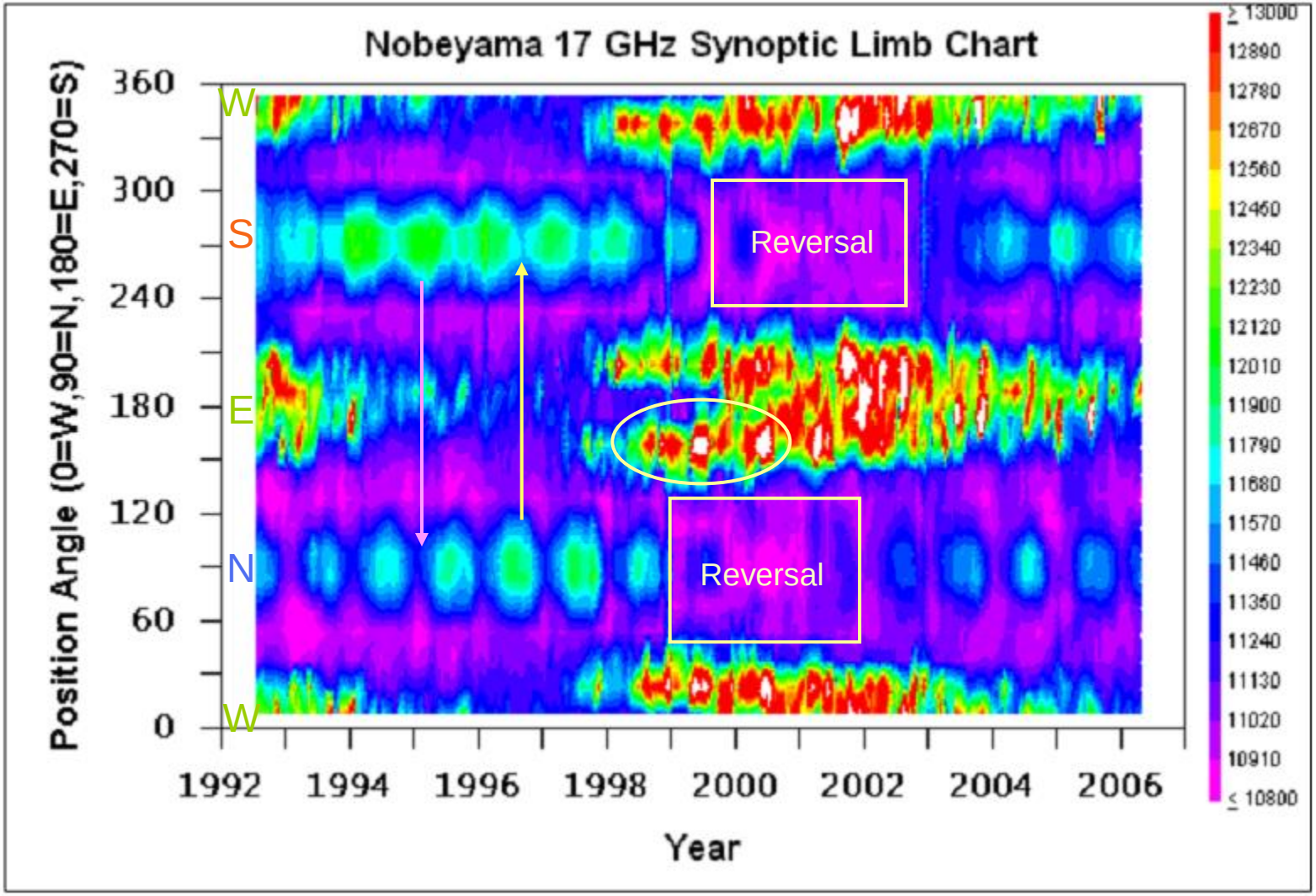




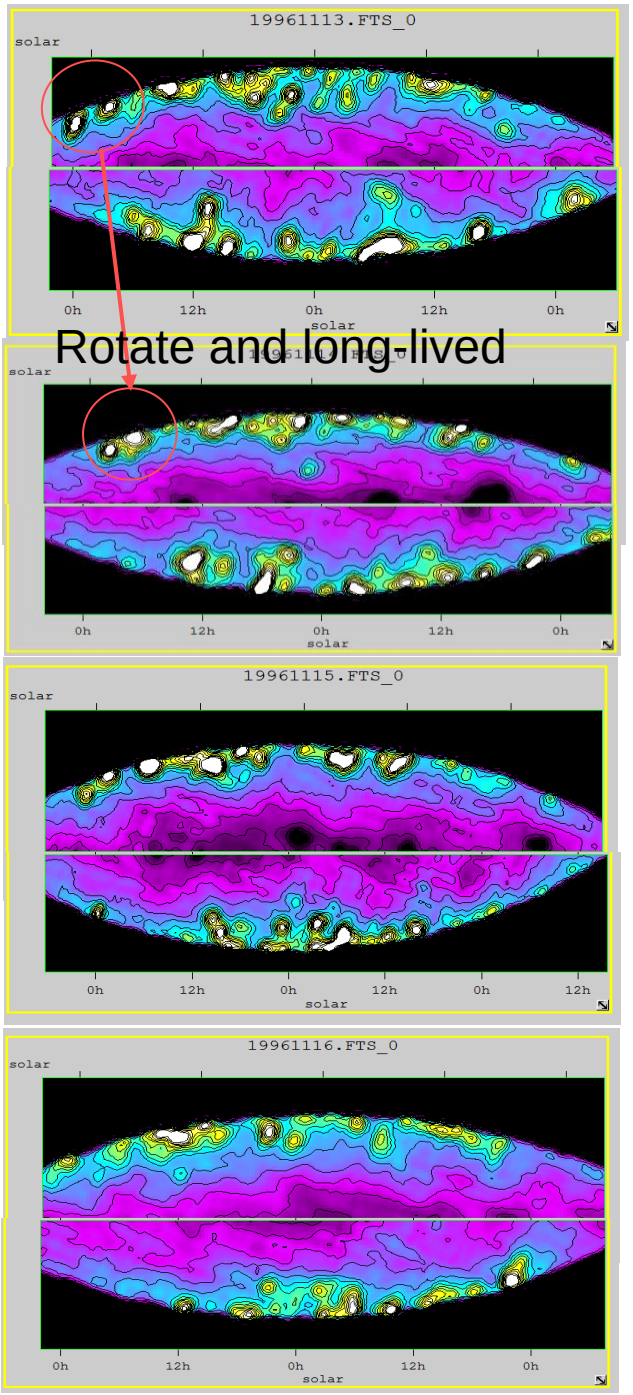
Another View of Polar Fields from the Nobeyama Radioheliograph

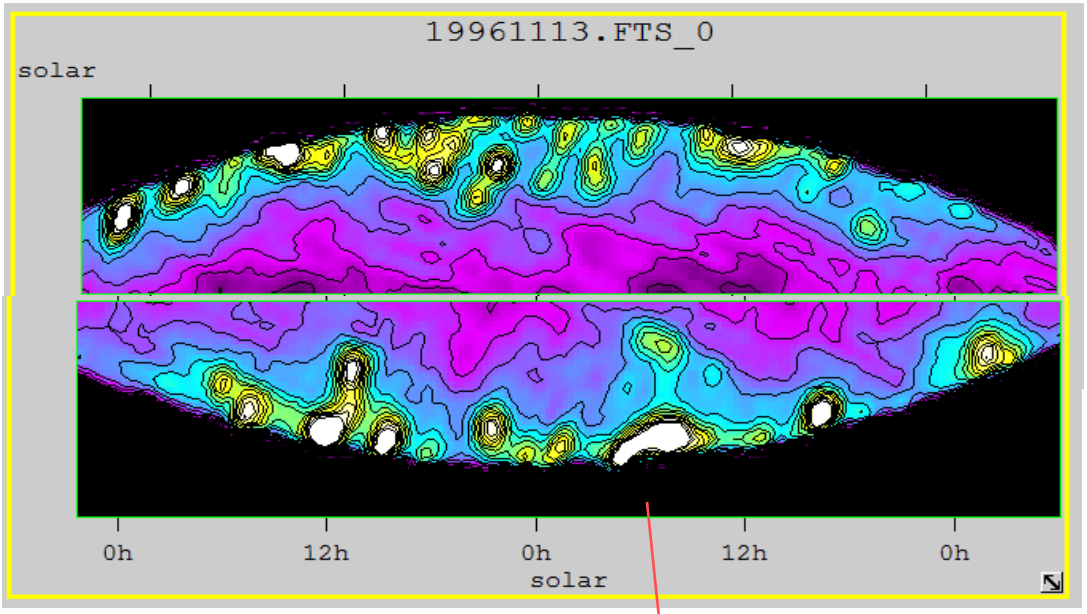


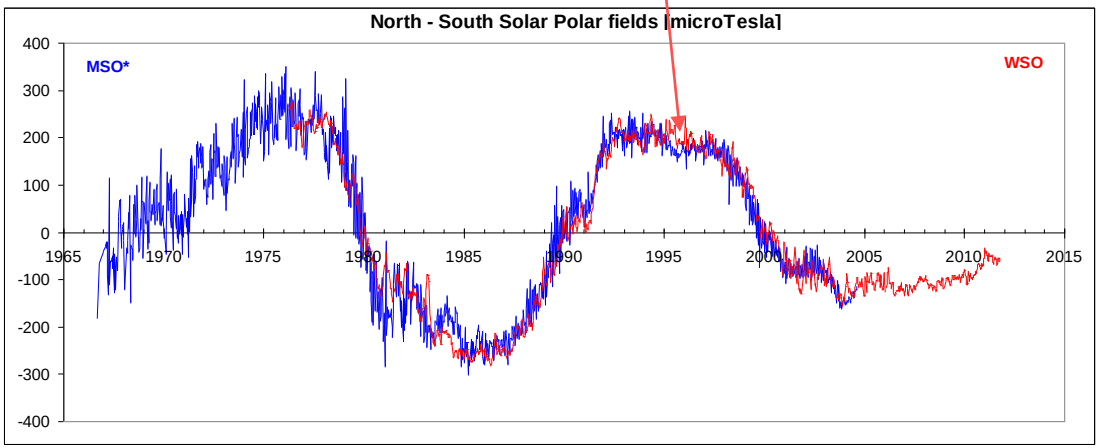
Evolution of Patches over the Cycle



At Solar Minimum patches are numerous and strong

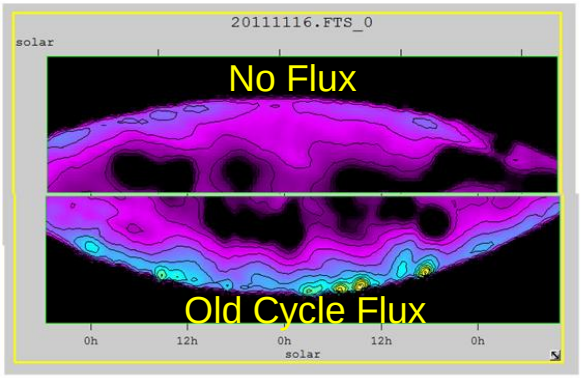


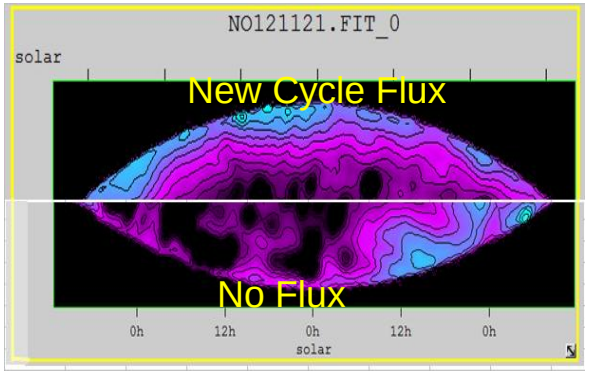




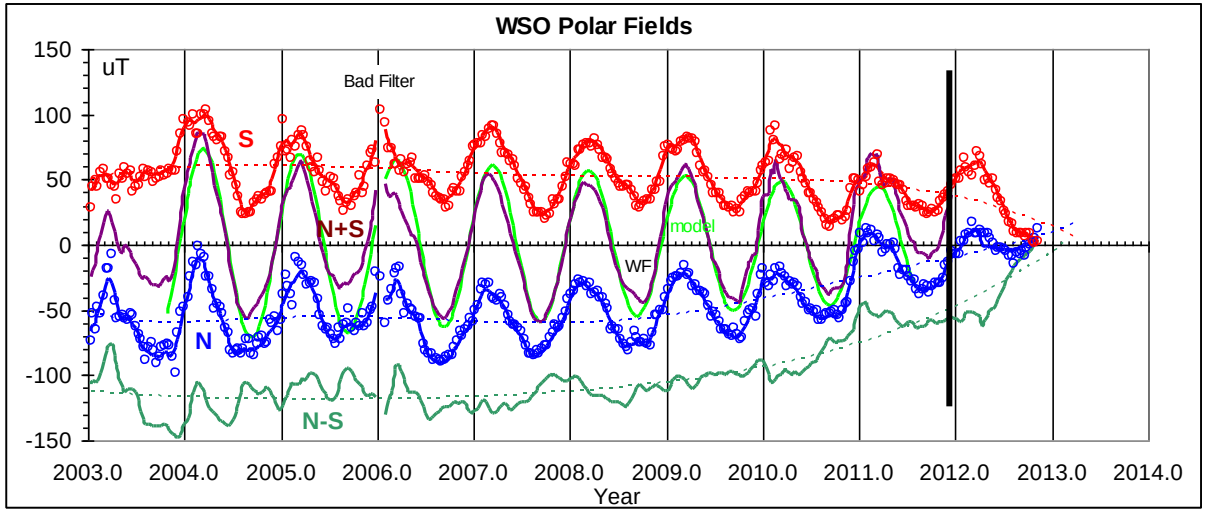
At Maximum they Disappear

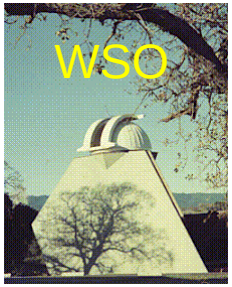
A year ago…

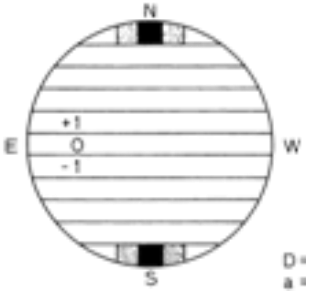




A week ago…







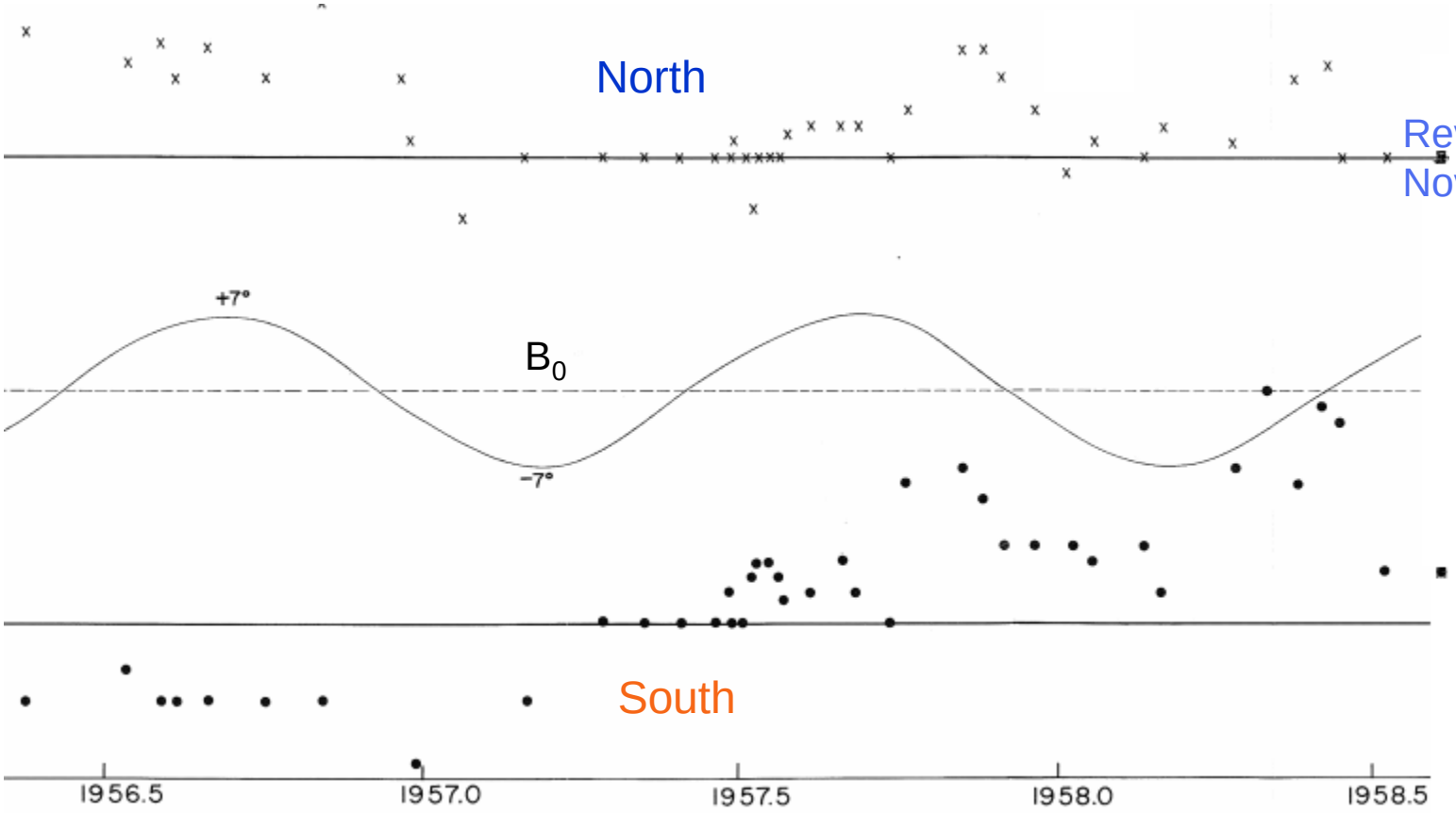
Average flux above 55°: First North reversing, now the South…

Answer: There is no flux judging from the 17GHz images

←

Question: At solar maximum, are the polar caps, when reversing field, covered with equal amounts of opposite polarity magnetic fluxes or isn't there any flux?

Babcock's Discovery of Polar Field [Asymmetric] Reversal, 1959



"Signs and average intensities of the sun's polar magnetic field. *Above*, north polar zone; *bottom*, south polar zone; *center*, earth's heliographic latitude"

Waldmeier Related the Asymmetric Reversal to Asymmetry in Activity

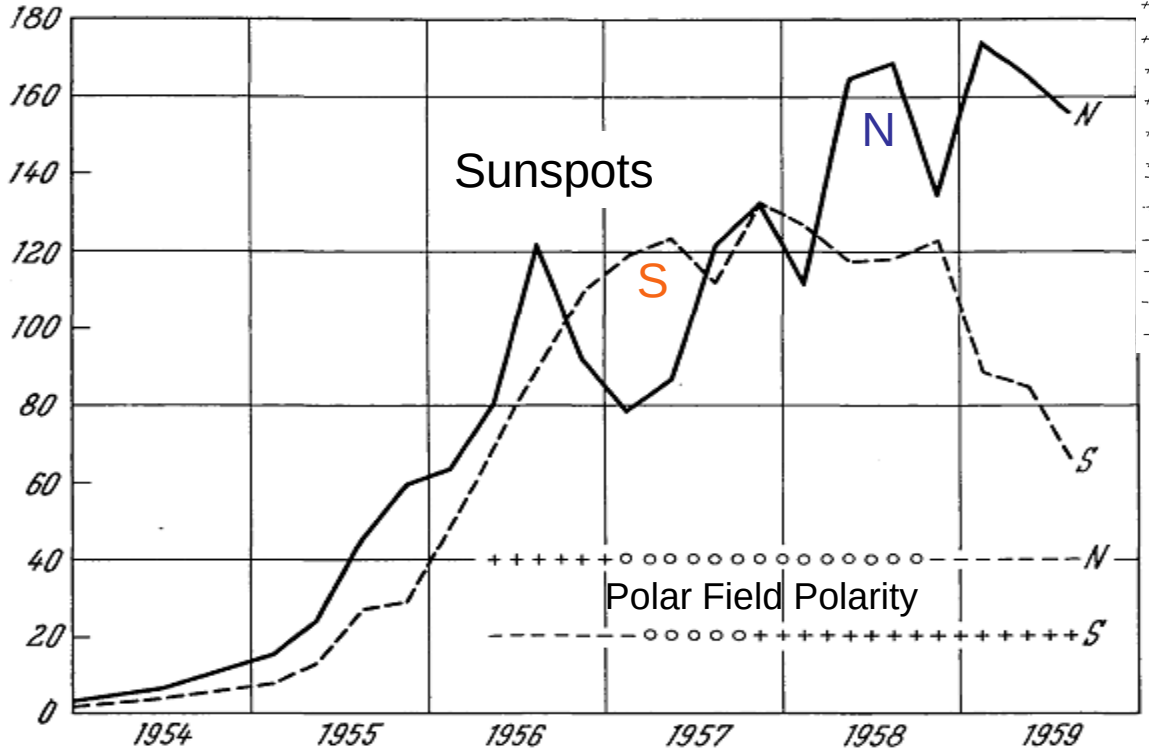
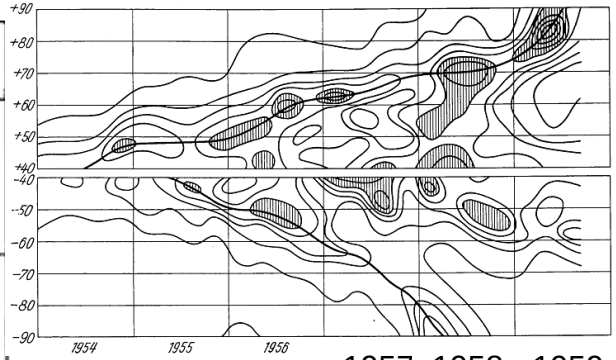


Abb. 1. Verlauf der Fleckentätigkeit und Variation des polaren Magnetfeldes

has pointed out, if the northern and southern hemispheres are considered separately, the sunspot numbers reached a maximum in the south about one year earlier than in the north, and this suggests a physical connection with the earlier reversal of the south polar field. Waldmeier (1960) quoted by Babcock (1963)



Occurrence of Prominences: "Rush to the Poles"

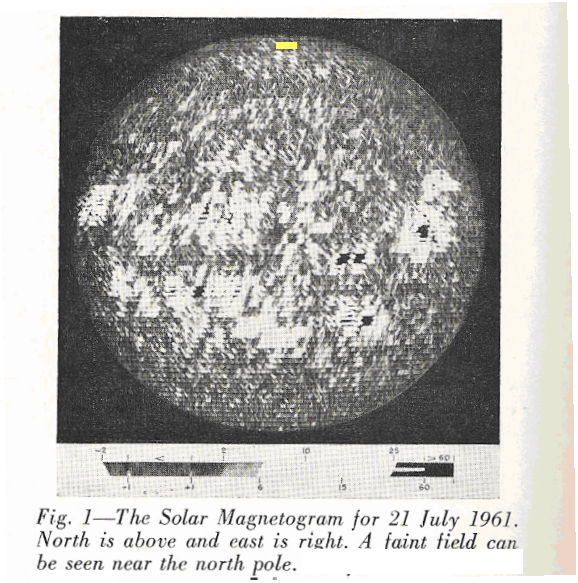
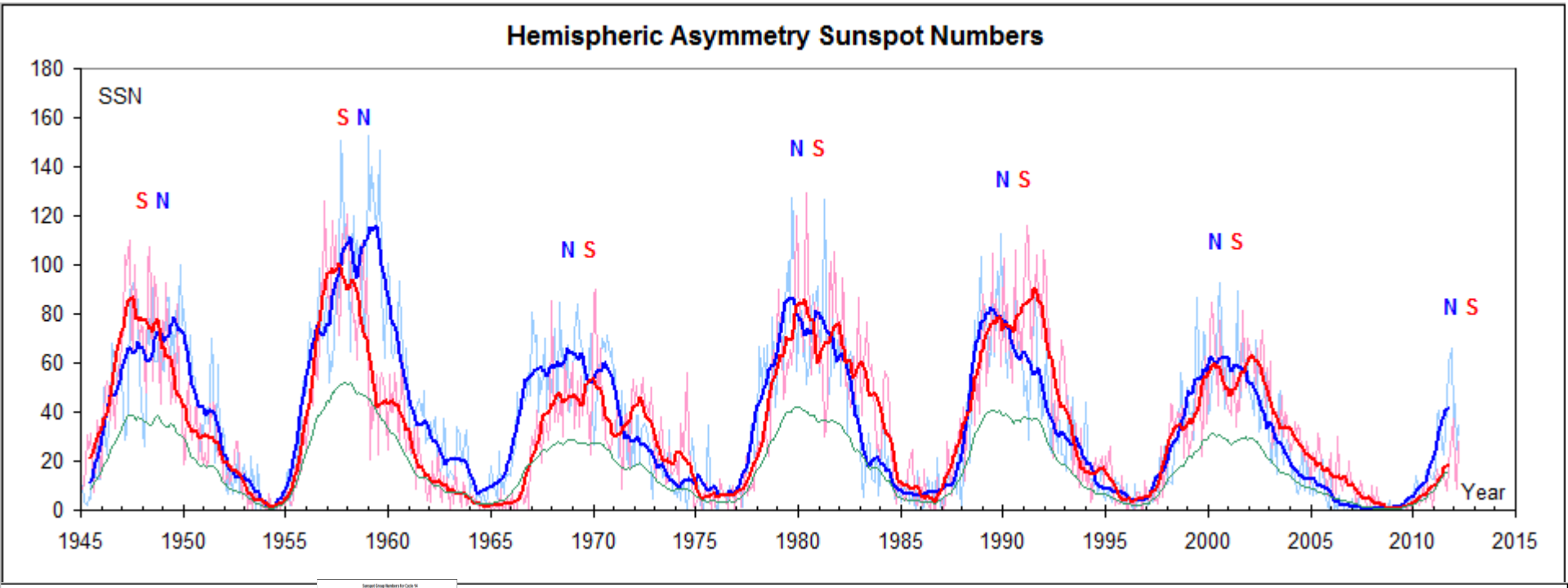
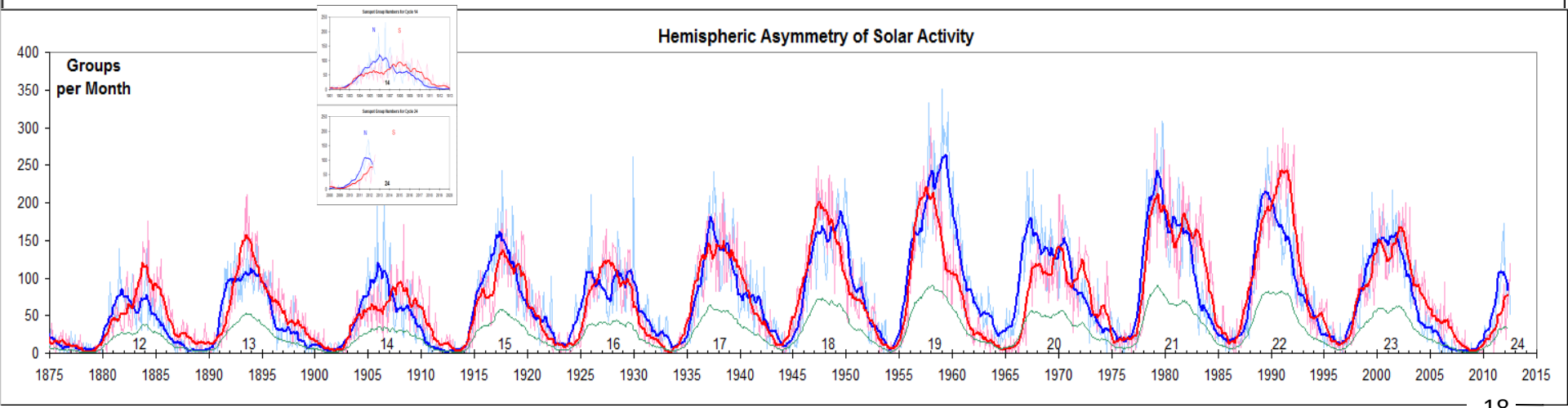


Fig. 1—The Solar Magnetogram for 21 July 1961. North is above and east is right. A faint field can be seen near the north pole.

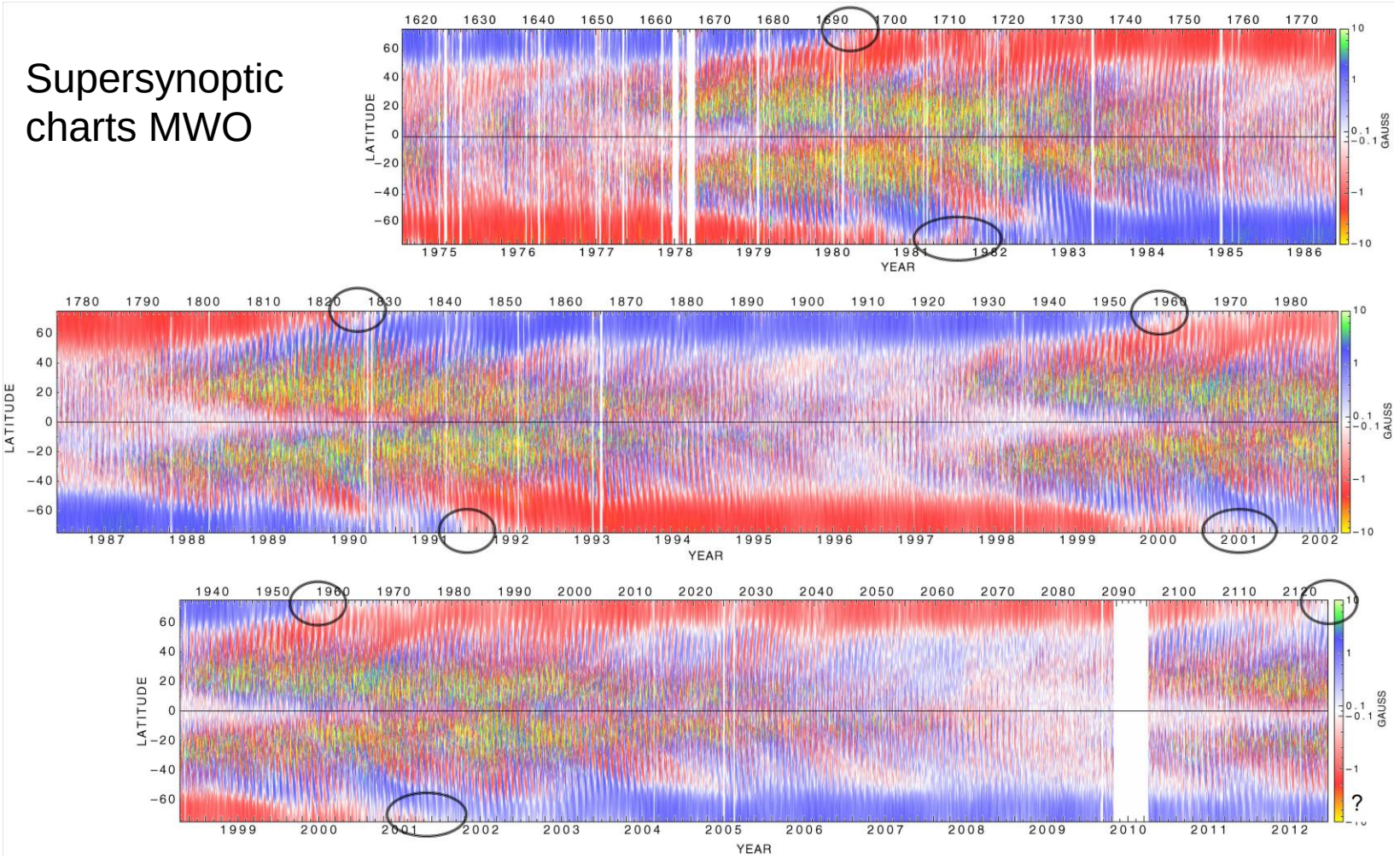
Asymmetric Solar Activity





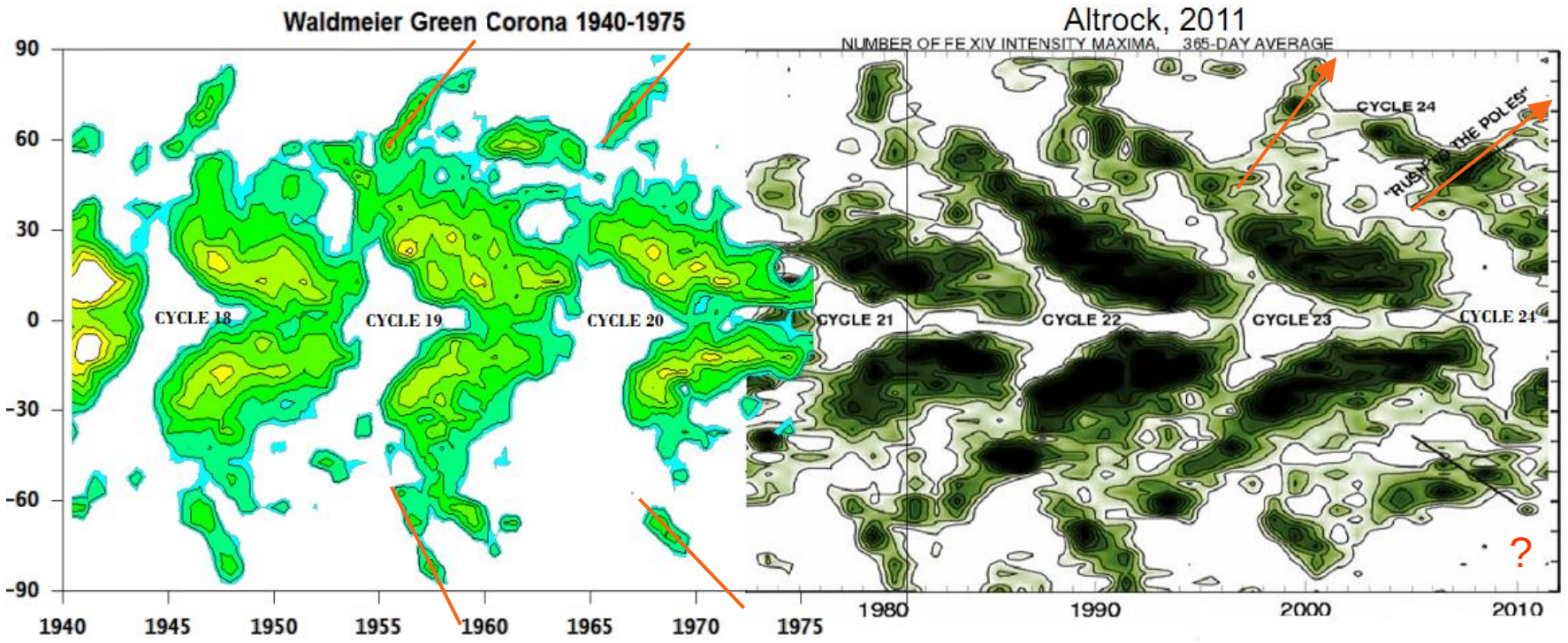
Observed Polar Field Reversals

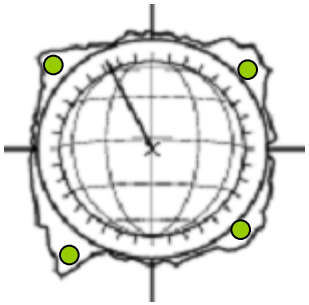
Supersynoptic charts MWO



MWO: Roger Ulrich, 2012

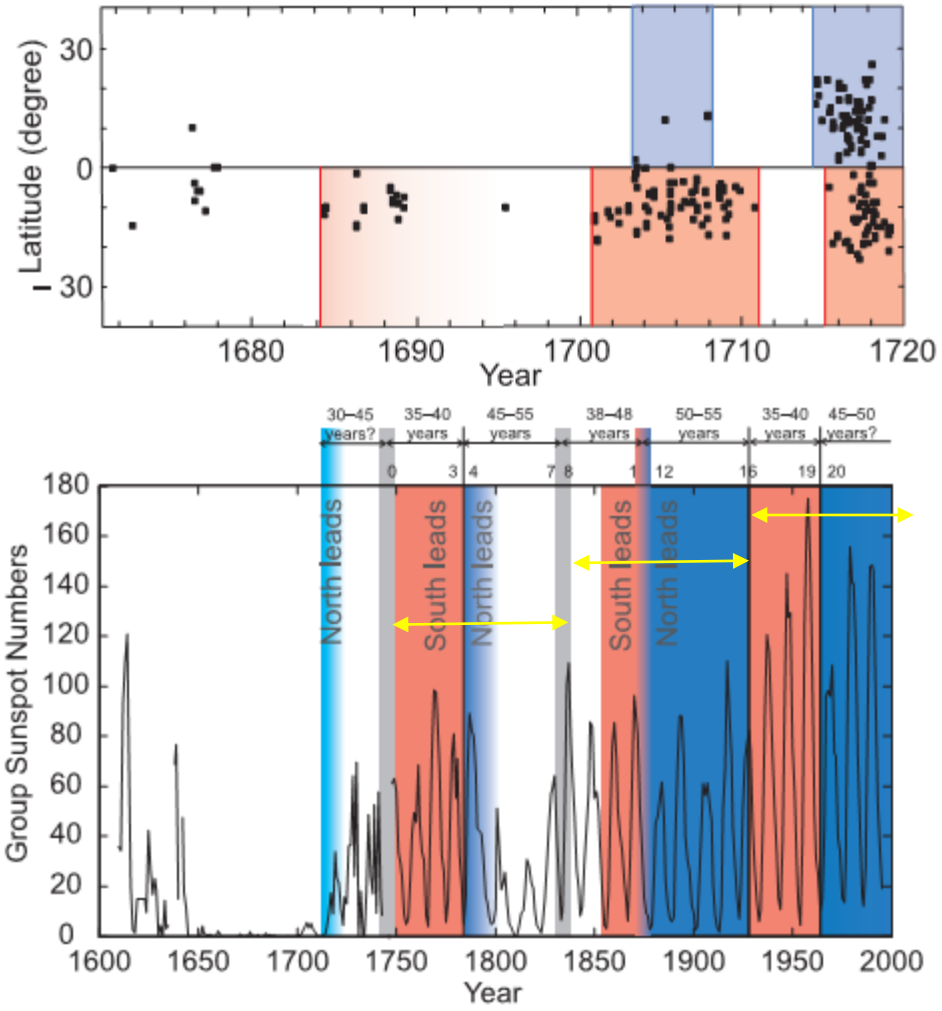
Also Visible in the ‘Rush to the Pole’ of Coronal Emissions





Measurements of the location of ‘peaks’ of Fe XIV coronal emission at 503 nm (the ‘Green Line Corona’) over 7 solar cycles. The plots show the probability of observing a ‘peak’ at a given latitude as a function of time.

70-100 Year ‘Gleissberg Cycle’ in Solar Activity Asymmetry?



Zolotova et al., 2010

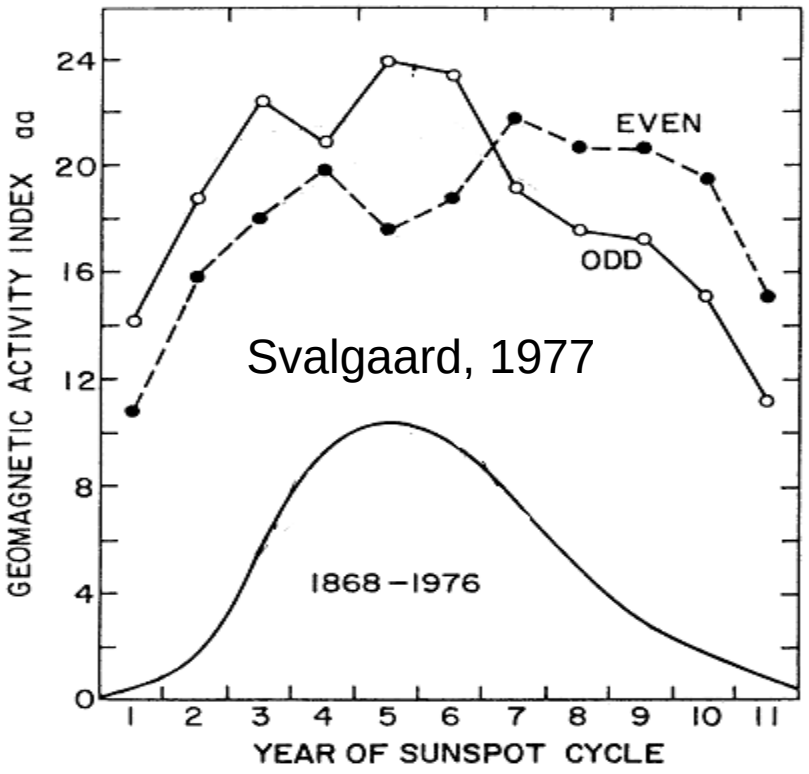
Extreme Asymmetry during the Maunder Minimum…

There are various dynamo theoretical ‘explanations’ of N-S asymmetry. E.g. Pipin, 1999. I can’t judge these…

Is this a ‘regular’ cycle or just over-interpretation of noisy data?

‘Prediction’ from this: South will lead in cycle 25 or 26 and beyond. We shall see…

How do we Know that the Poles Reversed Regularly before 1957?

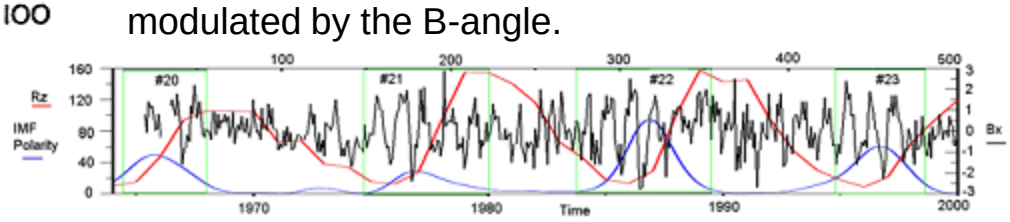


Svalgaard, 1977

"Thus, during last eight solar cycles magnetic field reversals have taken place each 11 year period". S-M effect. Vokhmyanin & Ponyavin, 2012

In any case, our result over a 45-year interval is probably the most direct evidence for a continuing change of the predominant polarity of the large-scale solar-magnetic field with a period equal to the sunspot magnetic cycle, i.e., ~20 years during this century. Wilcox & Scherrer, 1972

The predominant polarity = polar field polarity (Rosenberg-Coleman effect) annually modulated by the B-angle.



This effect combined with the Russell-McPherron effect [geomagnetic activity enhanced by the Southward Component of the HMF] predicts a 22-year cycle in geomagnetic activity synchronized with polar field reversals, as observed (now for 1840s-Present).

Conclusions and Speculation

- In every cycle since the polar fields were first observed, the reversals have been at different times, and simply following the prevailing activity asymmetry
- Polar fields have reversed in every cycle since at least the 1840s
- Asymmetric activity may be organized on longer time scales [i.e. not random]

The End

Abstract

The solar polar fields reverse because magnetic flux from decaying sunspots moves towards the poles, with a preponderance of flux from the trailing spots. Let us assume that there is a strong asymmetry in the sense that all activity is in the Northern Hemisphere, then that excess flux will move to the North Pole and reverse that pole, while nothing happens in the South. If later on, there is a lot of activity in the South, then that flux will help reverse the South Pole. In this way, we get two humps in solar activity and a corresponding difference in time of reversals. Such difference was first noted by Babcock in 1959 from the very first observation of polar field reversal just after the maximum of strongly asymmetric solar cycle 19. At that time, the Southern Hemisphere was most active in the beginning of the cycle and the South Pole duly reversed first, followed by the Northern Hemisphere more than a year later. Babcock noted that "For more than a year, the unexpected peculiarity was presented of two poles with the same sign". Solar cycles since then have had the opposite asymmetry, with the Northern Hemisphere being most active early in the cycle. Polar field reversals for these cycles have as expected happened first in the North. This is especially noteworthy for the present solar cycle 24. We suggest that the association of two peaks of solar activity when separated by hemispheres with correspondingly different times of polar field reversals is a general feature of the cycle.

http://www.leif.org/research