SH51A-1593

Predicting Solar Cycle 24 (Using Solar Polar Fields)

*L Svalgaard, K H Schatten

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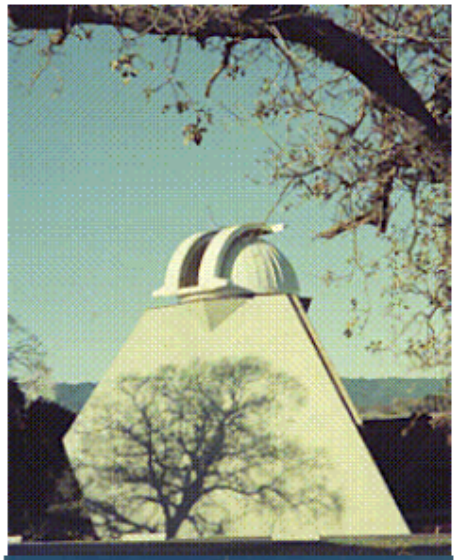
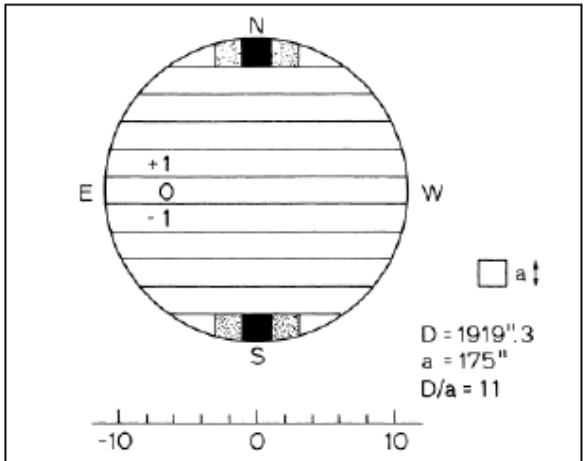
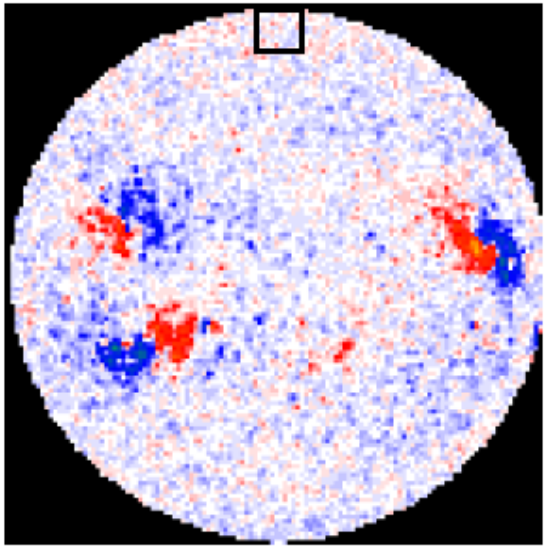
Definition of Polar fields







Wilcox Solar Observatory (WSO)

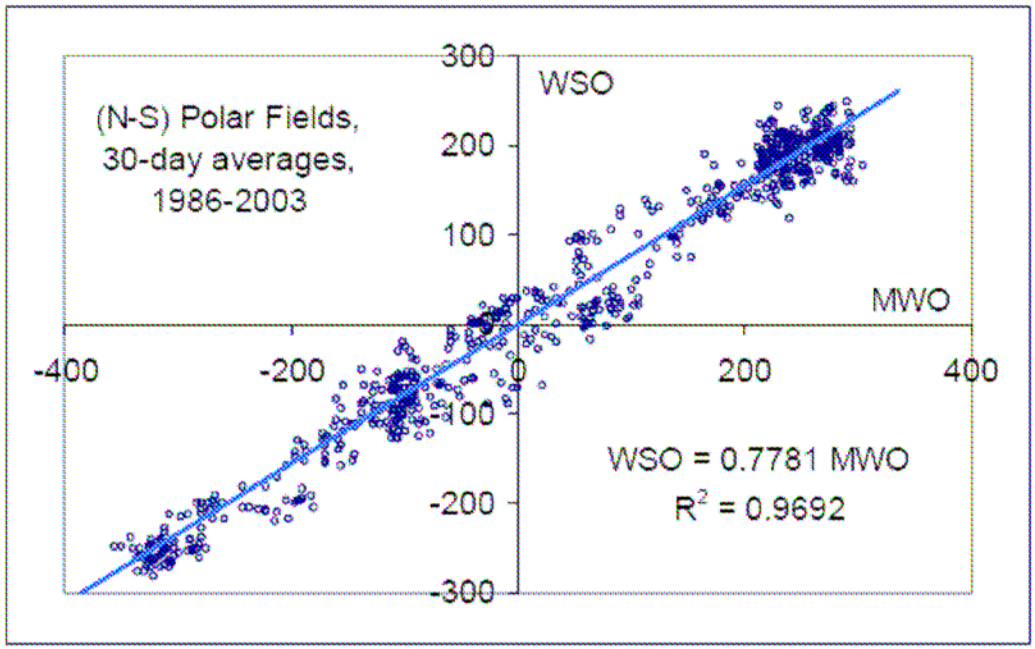
Large aperture: 3’

Operational Definition of Polar Fields:
Average field in pole-most apertures (black squares)

Mount Wilson Observatory (MWO)

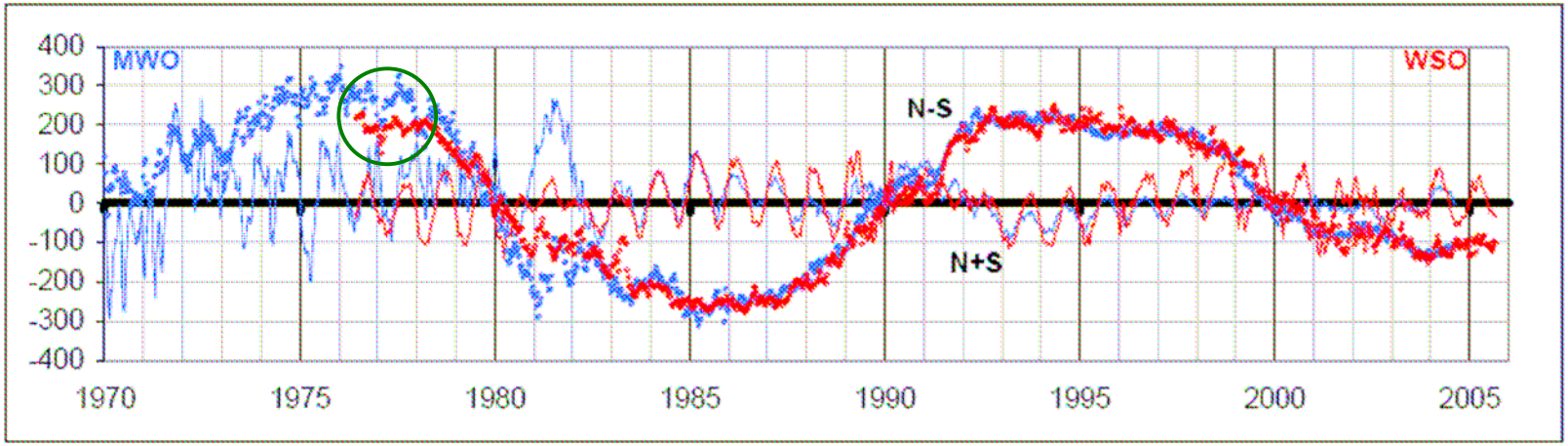
Small aperture: 0.2’

Operational Definition of Polar Fields:
Average field of pixels inside aperture that matches that of WSO



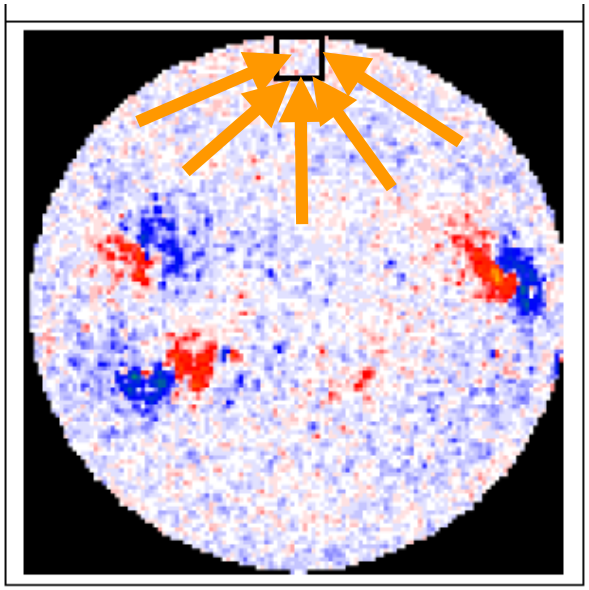
A measure of the "dipole moment" is the difference between the polar fields in the two hemispheres (North and South). Taking the difference also compensates for zero-level errors. In spite of the difference in apertures (3' for WSO and 0.2' for MWO), the two observatories agree very well ($R^2 = 0.97$). Before the upgrade of MWO in late 1985, the relationship was different: WSO = 1.325 MWO.

We can now reduce MWO polar fields to the WSO scale. Before 1983, MWO is noisy and has at times large zero-level errors. Before 1980, WSO suffered from scattered light (dirty optics!). So, early data before 1983 are less reliable. From 1986 on, the two observatories agree closely. Here we show the difference (N-S) and the sum (N+S) of the polar fields:



The difference (N-S) shows a measure of the dipolar fields because the annual modulation cancels out, while the sum (N+S) shows a measure of the annual modulation because the solar dipole cancels out. Just after dipole reversal, the annual modulation is not present, but as we approach sunspot minimum (where the dipole is strongest), the modulation sets in.

We were puzzled by the disagreement in 1976-1977 [green circle] where WSO seemed too low.

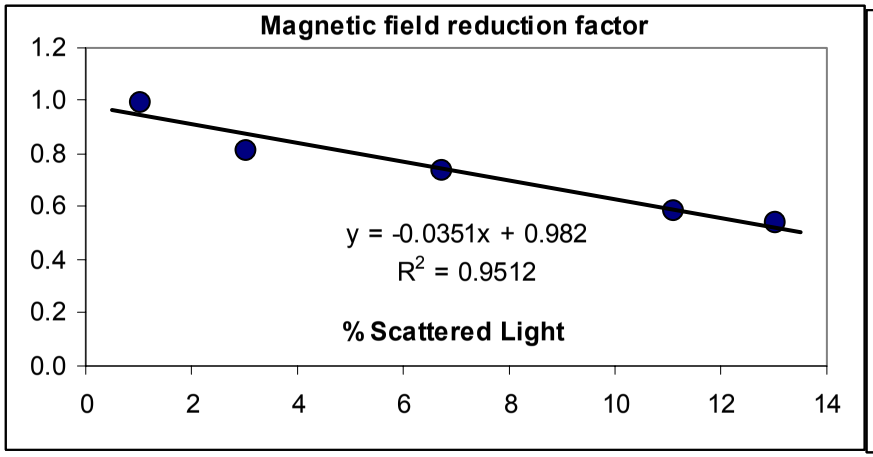


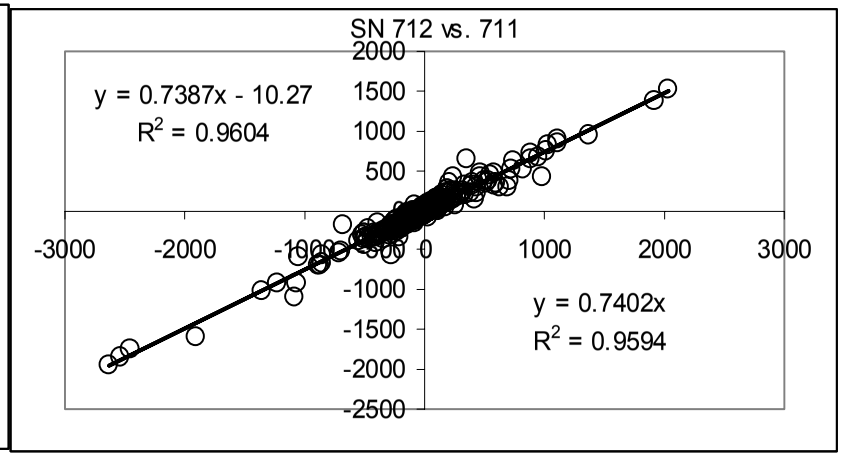
Scattered light is the reason for the lower WSO fields, as light from mixed polarity areas are scattered into the polar aperture, diluting the measured polar field.

Making the mirrors dirty on purpose shows the effect very clearly:

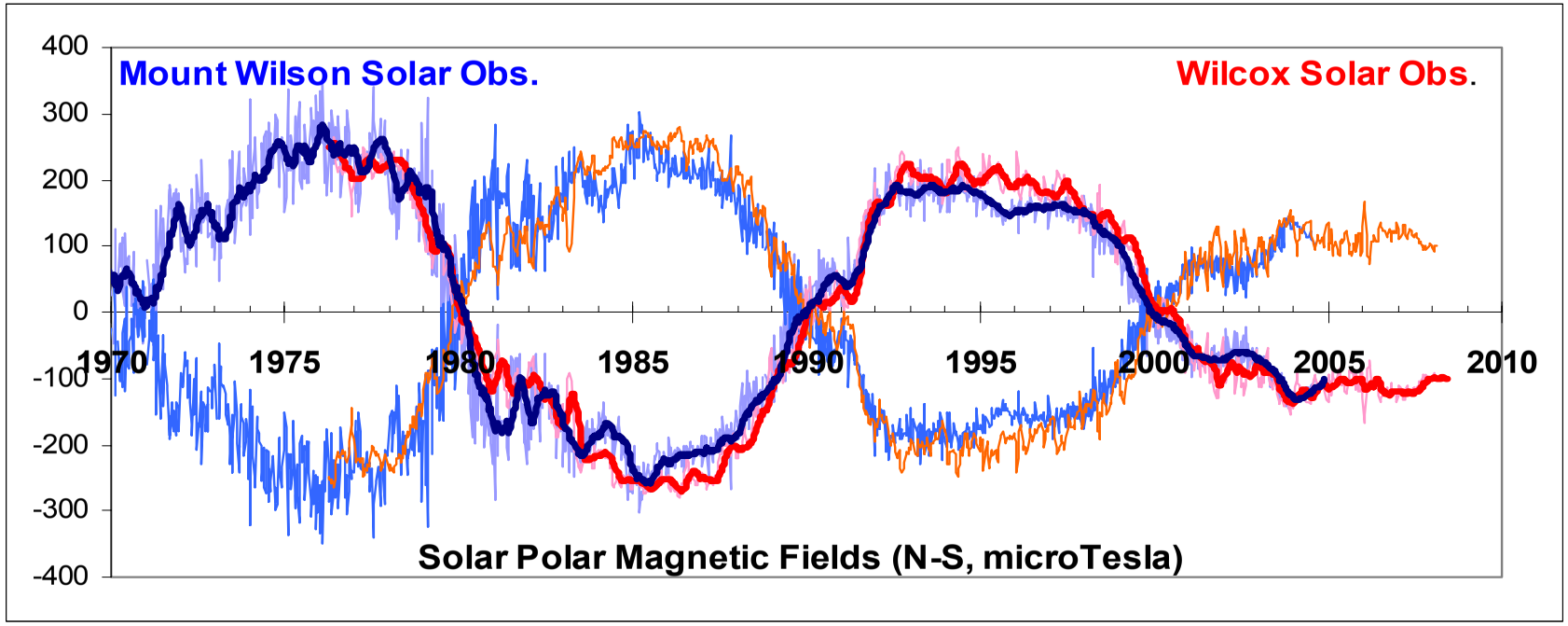
scattered %	Reduction
1.0	1.0000
3.0	0.8178
6.7	0.7402
11.1	0.5869
13.0	0.5424

Each % of scattered light decreases B by ~3.5%



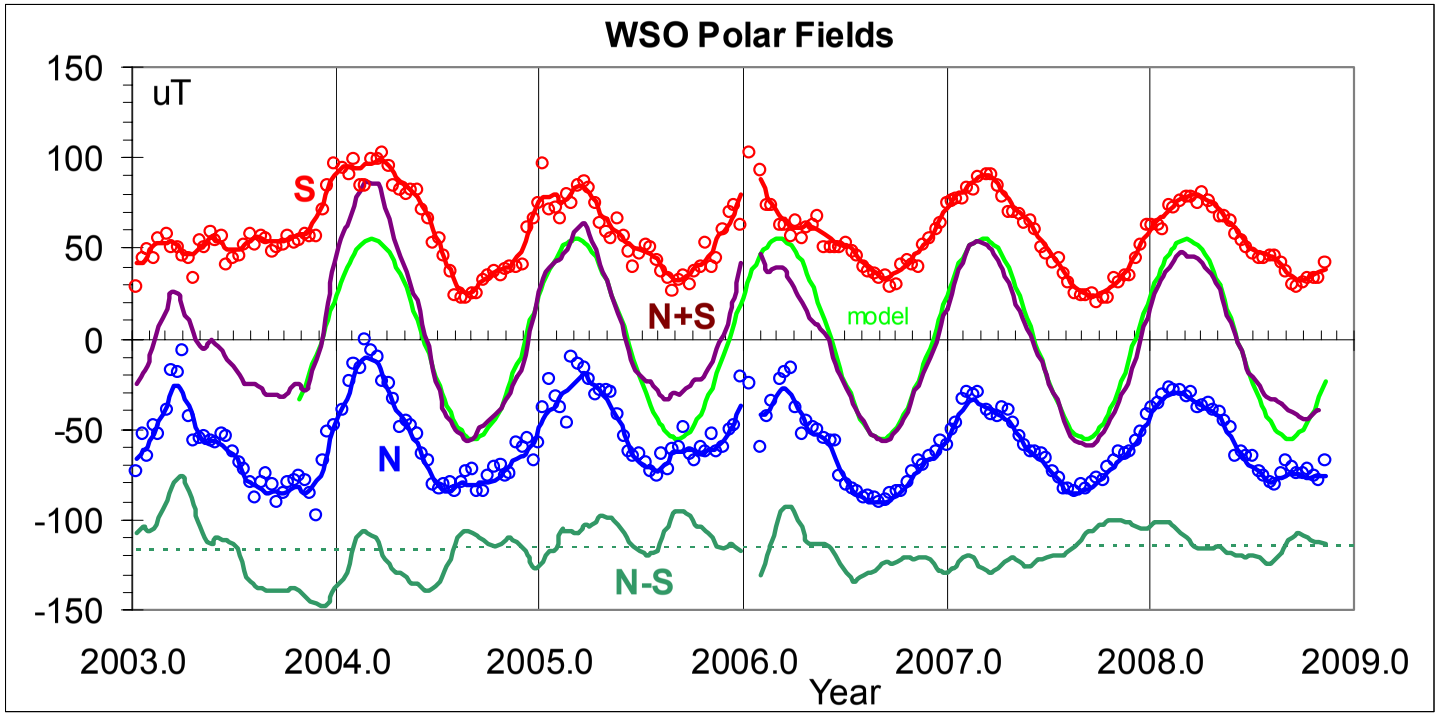


During 1976-1077 scattered light was typically ~5%, for a total of corresponding 17.5% decrease of B, so the observed 'dipole moment' should be increased accordingly. Correcting for this, we get:



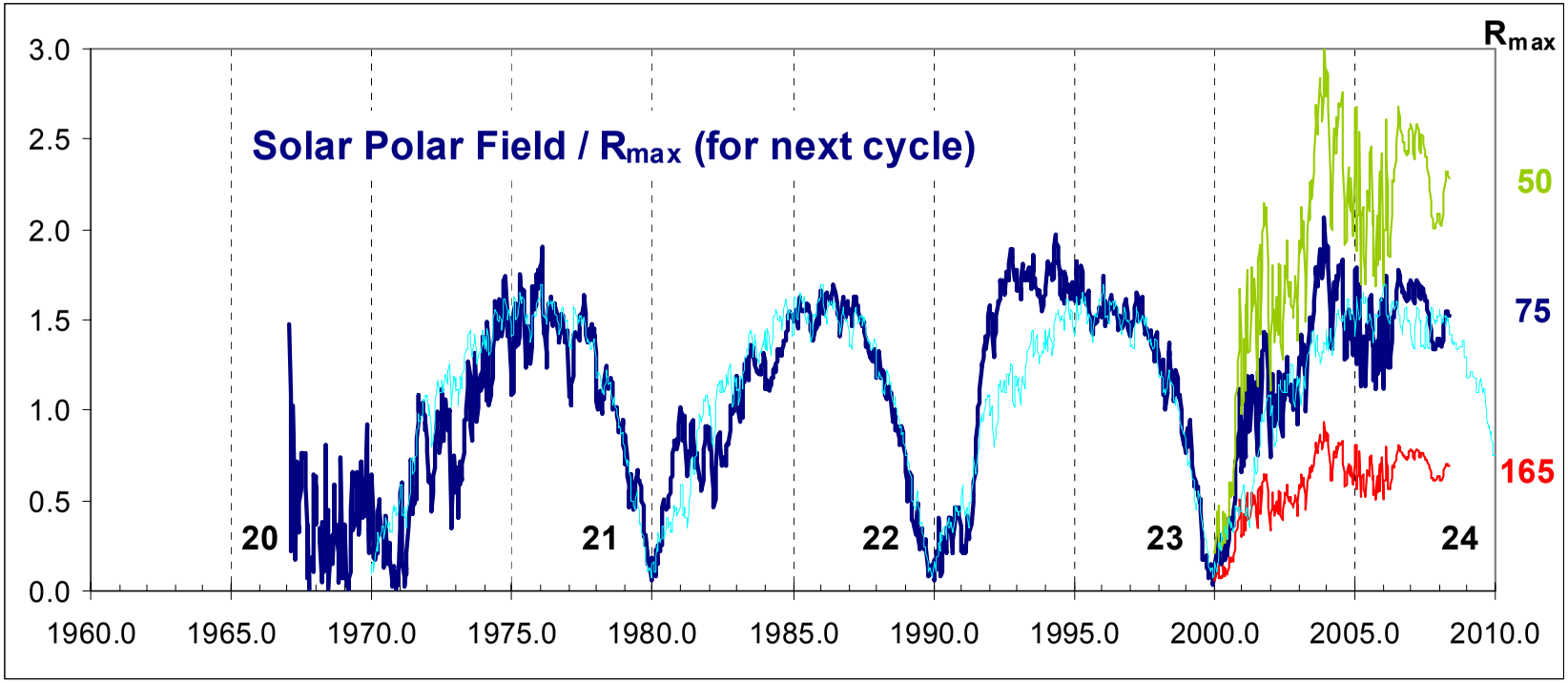
Showing the steady decline of the polar fields, commensurate with the decline of the solar cycle maxima, and foreboding a weak cycle 24.

Detailed Recent Polar Fields

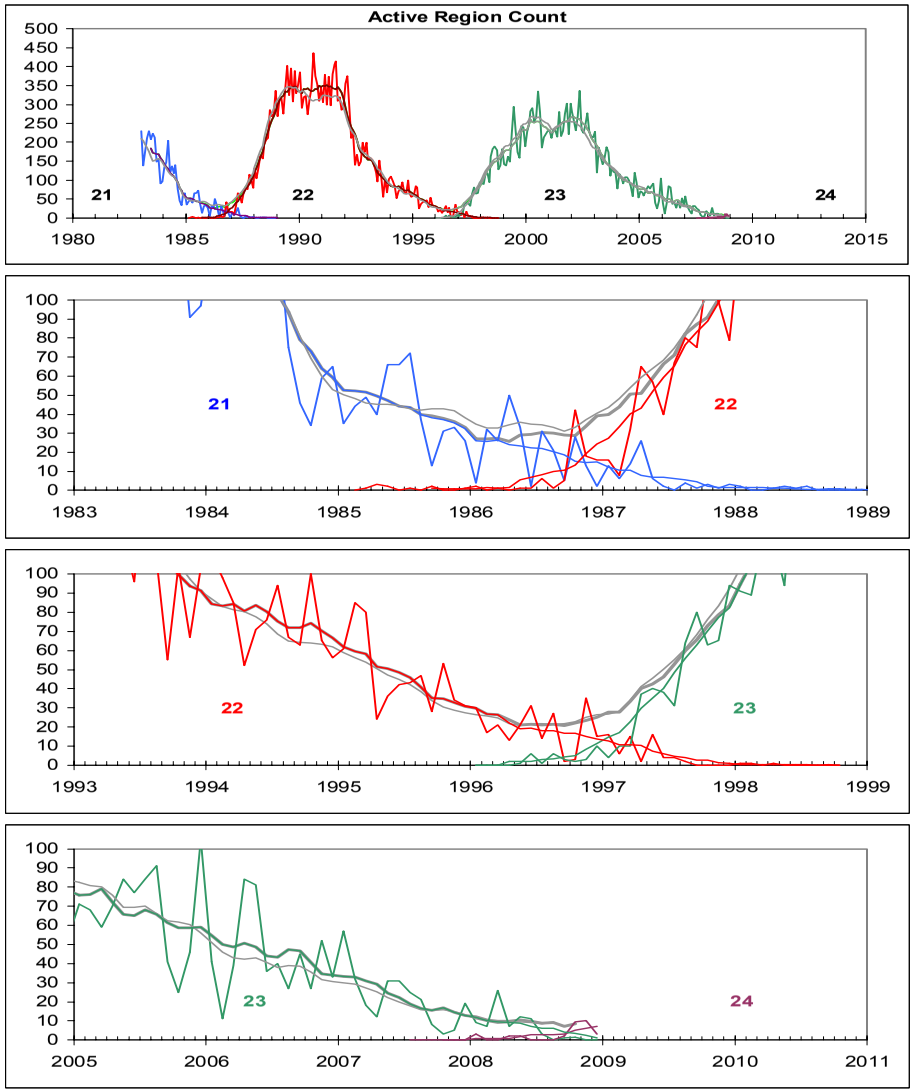


Detail of WSO polar fields. The N-S difference has stayed practically constant the last several years. Formally that corresponds to Rmax = 71, using the relation of Svalgaard et al. [2005].

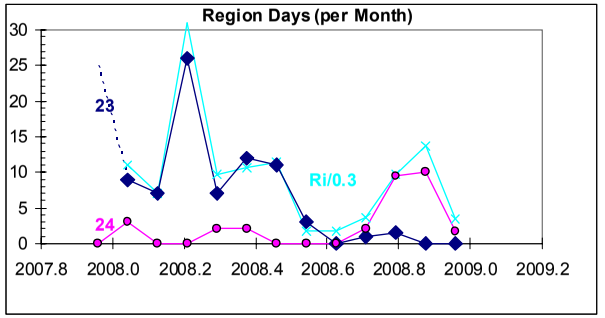
Normalized Solar Polar Field



The solar polar field DM = abs (North - South) μT divided by the size (max. smoothed sunspot number) of the following sunspot cycle [dark blue]. Average curve [light blue]. For cycle 24 we don't know the size yet so three choices are shown: Rmax = 50 [green], = 75 [continued dark blue] and = 165 [red].



So, how are we doing? The new cycle seems to have started placing the minimum around August 2008, but does not look very vigorous. The new cycle spots have been small and short-lived.



The 'region-days' are determined by adding up the number of regions per day.

The 'cross-over' point where new-cycle spots outnumber old-cycle spots may have been reached as well.