How Well Do We Know the Sunspot Number?

[And what we are doing to answer that question]

Leif Svalgaard
Stanford University
Colloquium at HAO, Boulder, 19 Sept. 2012
Outline

• Effect of Weighting on Zürich SSN
• What is Wrong with the Group SSN
• Geomagnetic Calibration of SSN
• What to Do about All This
• Future Assessment of Solar Activity
The Effect of Weighting in Counting Sunspots

‘The Waldmeier Discontinuity’

The directors of Zürich Observatory were:
1864-1893 Johann Rudolf Wolf (1816-1893)
1894-1926 Alfred Wolfer (1854-1931)
1926-1945 William Otto Brunner (1878-1958)
1945-1979 Max Waldmeier (1912-2000)
Waldmeier (1960) claimed that a counting with weighting began in 1882:

**CHANGES TO THE COUNTING METHOD**

Since Rudolph Wolf began the sunspot measurement, he set the standard. And although he counted each spot regardless of its size, he failed to include those smallest spots visible only under a stable atmosphere. Around 1882 Wolf's successors permanently changed the counting method in two ways to compensate for the large variation in spot size:

1. by including the smallest spots visible under an atmosphere of constant transparency and
2. by weighting spots with penumbrae according to their size and umbral structure.

This ‘modified’ counting method is still in use at the reference station Locarno used by SIDC in Brussels.

Relative Sunspot Number = K (10*Groups + Spots)
Wolfer’s Change to Wolf’s Counting Method

- Wolf only counted spots that were ‘black’ and would have been clearly visible even with moderate seeing, so did not count the smallest spots [to be compatible with Schwabe]
- His successor Wolfer disagreed, and pointed out that the above criterion was much too vague and instead advocating counting every spot that could be seen
- This, of course, introduces a discontinuity in the sunspot number, which was corrected by using a much smaller $K$ value [~0.6 instead of Wolf’s 1.0]
- All subsequent observers have adopted that same 0.6 factor to stay on the original Wolf scale for 1849-~1865
- Waldmeier claimed that beginning in 1882, the Zürich observers began to count large spots with higher weight
- Wolfer states categorically in 1907 that every spot is counted only once regardless of its size
Waldmeier’s Description of his [?] Sunspot Counting Method

“A spot like a fine point is counted as one spot; a larger spot, but still without penumbra, gets the statistical weight 2, a smallish spot with penumbra gets 3, and a larger one gets 5.” Presumably there would be spots with weight 4, too.

This very important piece of metadata was strongly downplayed and is not generally known.
Drawing from Locarno 21 October, 2010 showing the three Locarno Regions 102, 104, and 107. The table gives the weight assigned to each group.

The raw sunspot number reported by Locarno (upper right-hand table) was $3 \times 10 + 11 = 41$, which with Locarno’s standard $k$-factor of 0.60 translates to a reduced relative sunspot number on the Wolf scale of $0.6 \times 41 = 25$ which was indeed what SIDC reported for that day.

Wolf would have reported $3 \times 10 + 4 = 34$, so rough indication of the effect of weighting would be $41/34 = 1.21$. 
From Hathaway’s list we get the areas of those spots:

<table>
<thead>
<tr>
<th>Year</th>
<th>M</th>
<th>D. UT</th>
<th>NOAA Loc#</th>
<th>Area (obs.)</th>
<th>Area (μH)</th>
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<td>10</td>
<td>21.50</td>
<td>11113</td>
<td>102</td>
<td>134 μH</td>
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<tr>
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<td>10</td>
<td>21.50</td>
<td>11115</td>
<td>104</td>
<td>223 μH</td>
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<tr>
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<td>10</td>
<td>21.50</td>
<td>11117</td>
<td>107</td>
<td>104 μH</td>
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</table>

-Note there is a spot of the same size back in 1920:
  1920 11 21.55 9263 MWO 223 μH (it was the only spot)
Up until Waldmeier [who discontinued this!] the Zürich observers recorded their raw data for each day in this format

“Group Count . Total Spot Count”

To calculate the relative sunspot number, e.g. on April 4th, one performs

\[ R = k \times (10 \times 12 + 58) = 178 \]

where the scale factor \( k \) is 1.00 for Wolf himself.
So, now back to the MWO spot on 21st Nov. 1920 that had the same size as Locarno 104 [which was counted as three spots or 1 spot with weight of 3.]

The insert shows a similar group observed at MWO on 5th Nov., 1922. For both groups, Wolfer should have recorded the observation as 1.3 if he had used the weighting scheme, but they were recorded as 1.1, clearly counting the large spots only once (thus with no weighting). The historical record Zürich sunspot number was 7 \(=0.6 \times (10+1)\) on both those days, consistent with no weighting.
Other Observatory Drawings Show Similar Results, e.g. Haynald (Kalocsa, Hungary):

This spot should have been counted with weight 3, so the recorded value should have been 1.3, if Wolfer had applied the weighting, which he obviously didn’t.
There are many other such examples, (e.g. 16th September, 1922 and 3rd March, 1924 for which MWO drawings are readily available).

In addition, Wolfer himself in 1907 (Mitteilungen, Nr. 98) explicitly states: “If an observer with his instrument on a given day notes \( g \) spot groups with a total of \( f \) single spots, without regard to their size, then the therefrom deduced relative number for that day is \( r = k(10g+f) \).” [Next slide]

We thus consider it established that Wolfer (and by extension [?] the other observers before Waldmeier) did not apply the weighting scheme contrary to Waldmeier's assertion.

This is consistent with the fact that nowhere in Wolf's and Wolfer's otherwise meticulous yearly reports in the *Mitteilungen über Sonnenflecken* series is there any mention of a weighting scheme. Waldmeier himself was an assistant to Brunner in 1936 and performed routine daily observations with the rest of the team so should have known what the rules were. There is a mystery lurking here. Perhaps the Archives [in Zürich? Or the microfilm in Brussels] will provide a resolution of this conundrum. [Unfortunately the Archives are lost]
Wolfer in 1907: Ohne Rücksicht auf deren Grösse
H. B. Rumrill’s Sunspot Observations

H. B. Rumrill (1867-1951) was a friend of Rev. Quimby [see later] and continued (1922 to 1951) Quimby’s observations of sunspots. His data and notebooks were considered lost until I with the help of ‘The Antique Telescope Society’ (Bart Fried, Jack Koester), located most of them in early 2012.

The ratio between the Zürich SSN and the Rumrill SSN gives additional support for the ‘Waldmeier Jump’
What Do the Observers at Locarno Say About the Weighting Scheme:

“For sure the main goal of the former directors of the observatory in Zürich was to maintain the coherence and stability of the Wolf number[...] Nevertheless the decision to maintain as “secret” the true way to count is for sure source of problems now!”

(email 6-22-2011 from Michele Bianda, IRSOL, Locarno)

Sergio Cortesi started in 1957, still at it, and in a sense is the real keeper of the SSN, as SIDC normalizes everybody’s count to match Sergio’s [multiplied by the adopted 0.6 k-factor]
Estimating Unweighted Sunspot Count From Locarno Drawings

<table>
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<th>g</th>
<th>f</th>
<th>t</th>
<th>B</th>
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<td>123</td>
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</table>

8 46 20
126 100
26% inflated

Unweighted count red

I have recounted the last 41500+ spots. How good is my count?
I proposed to the Locarno observers that they should also supply a raw count without weighting.

For typical number of spots the weighting increases the ‘count’ of the spots by 30-50% (44% on average).
Comparison of ‘Relative Numbers’

But we are interested in the effect on the Relative SSN where the group count will dilute the effect by about a factor of two. The result is that there is no difference between Svalgaard and Cagnotti. We take this a [preliminary] justification for my determination of the influence of weighting [+16%] on the Locarno [and by extension on the Zürich and International] sunspot numbers.
How Many Groups?
The Waldmeier Classification May lead to Better [larger] Determination of Groups

Locarno
2011-09-12
MWO only
1 group

Locarno: 9 groups
2011-06-03
MWO has only 6 groups this day

NOAA only
1 group

2011-08-16
Counting Groups

• This deserves a full study. I have only done some preliminary work on this, but estimate that the effect amounts to a few percent only, perhaps 5% [?] One day in five has an ‘extra’ group. This work in ongoing.
• This would increase the ‘Waldmeier Jump” to about 21%
• My suggested solution is to increase all pre-Waldmeier SSNs by ~20%, rather than decrease the modern counts which may be used in operational programs

• http://www.leif.org/EOS/Kopecky-1980.pdf specifically notes that “according to [observer] Zelenka (1979a), the introduction of group classification with regard to their morphological evolution by Waldmeier and Brunner, has led to increased estimates of number of groups in comparison with Wolfer’s estimates”
• Exactly when this began is under investigation, but ‘some time in the 1940s’ is a good guesstimate for now
Can we validate this Inflation using other data? Comparing with the Group Sunspot Number:

We can compute the ratio WSN (Rz)/GSN (Rg) [staying away from small values] for some decades on either side of the start of Waldmeier’s tenure, assuming that GSN mainly derived from the RGO [Greenwich] photographic data has constant calibration over that interval. There is a clear discontinuity corresponding to a jump of a factor of 1.22 around 1946. This compares favorably with the estimated size of the increase due to the weighting [and more groups]
Sunspot Areas vs. Rz

The relationship between sunspot number and sunspot area [SA, Balmaceda] is not linear, but can be made linear raising SA to the power of 0.732. Then taking the ratio makes sense.

Clear change in the relationship around 1945
Comparison

Observed

Rz and Rz

Calculated from

projected

[observed]

Sunspot

Areas

The post-1945 Zürich Sunspot Numbers are observed to be 21% higher than for the same sunspot area before 1945.

$R_z = 0.3244^{*}SA^{0.732}$
Ca II K-line Data Scaled to Rz shows similar Jump in Rz Sunspot Number after 1945

From ~40,000 CaK spectroheliograms from the 60-foot tower at Mount Wilson between 1915 and 1985, a daily index of the fractional area of the visible solar disk occupied by plages and active network has been constructed [Bertello et al., 2008]. Monthly averages of this index is strongly correlated with the sunspot number SSN = 27235 CaK – 67.14 [before 1945].

Waldmeier’s Sunspot Number 19% higher than Brunner’s from Ca II K-line
The Amplitude of the Diurnal Variation, $r_Y$, [from many stations] shows the same Change in $R_z$ ~1945

We’ll return to this relationship later in the talk
The shift in SSN to bring the curves for cycles 17 and 18 to overlap is 21%.

So, many lines of evidence point to an about 20% Waldmeier Weighting Effect.

We can compensate for the effect by increasing all pre-1945 values by 20%.
The Effect on the Sunspot Curve

No long-term trend the last 300 years
What is Wrong with the Group Sunspot Number and How to Fix it
Researchers tend to cherry-pick the one that supports their pet theory the best – this is not a sensible situation. We should do better.
The Ratio Group/Zurich SSN has Two Significant Discontinuities

At ~1946 (After Max Waldmeier took over) and at ~1885
Removing the Recent one [+20\%] by Multiplying $R_z$ before 1946 by 1.20, Yields

Leaving one significant discrepancy $\sim 1885$
The Sunspot Number(s)

- Wolf Number = $K_W (10^*G + S)$
- $G =$ number of groups
- $S =$ number of spots

Rudolf Wolf (1816-1893) Observed 1849-1893

Ken Schatten

Group Number = 12 $G$

Douglas Hoyt and Kenneth Schatten devised the Group Sunspot Number using just the group count (1993).
Groups have $K$-factors too


\[ R_{\text{Group}} = \text{Norm-factor } G \]

there is no $K$ factor. In essence, this is because all telescopic observers see the same groups (at least statistically), so a spot count based on $G$ alone will be free of biases.

Alas, as H&S quickly realized, different observers do not see the same groups, so a correction factor, $K_G$, had to be introduced into the Group Sunspot Number as well:  

\[ R_{\text{Group}} = 12 K_G G \]  

[averaged over all observers]

And therein lies the rub: it comes down to determination of a $K$-value for each observer [and with respect to what?]
With respect to what?

H&S compared with the number of groups per day reported by RGO in the ‘Greenwich Helio-Photographic Results’. The plates, from different instruments on varying emulsions, were measured by several [many] observers over the 100-year span of the data.

H&S – having little direct evidence to the contrary - assumed that the data was homogenous [having the same calibration] over the whole time interval.

We’ll not make any such assumption. But shall compare sunspot groups between different overlapping observers, assuming only that each observer is homogenous within his own data (this assumption can be tested as we shall see)
Wolfer = 1.653±0.047 Wolf

$R^2 = 0.9868$

Wolfer saw 65% more groups than Wolf. No wonder, considering the difference in telescopes.
The K-factor shows in daily values too

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<th>Day</th>
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<th>Wolf S</th>
<th>Wolf R</th>
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Average 3.29 7.35 40.29 6.41 49.47 113.59

G Ratio x1.5  S Ratio x0.6

To place on Wolf’s scale with the 80mm 60 1.95 6.73 68
We can make the same type of comparison between observers Winkler and Wolfer.

Again, we see a strong correlation indicating homogenous data.

Again, scaling by the slope yields a good fit.
And between Rev. A. Quimby [Philadelphia] and Wolfer

Same good and stable fit

Quimby’s friend H. B. Rumrill continued the series of observations until 1951, for a total length of 63 years.
Making a Composite

Comparison Sunspot Groups and Greenwich Groups

Matched on this cycle

Compare with group count from RGO [dashed line] and note its drift
Early on, RGO count fewer groups than the Sunspot Observers. There was a significant fraction of days with no observations. H&S count these days as having a group count of zero, worsening the trend.
Why are these so different?

Our K-Factors vs. H&S’s

<table>
<thead>
<tr>
<th>Observer</th>
<th>H&amp;S RGO</th>
<th>to Wolfer</th>
<th>Begin</th>
<th>End</th>
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No correlation

K-factors

This analysis

Number of Groups

2% diff.
Why the large difference between Wolf and Wolfer?

Because Wolf either could not see groups of Zurich classes A and B [with his small telescope] or deliberately omitted them early on when he used the standard 80mm telescope. The A and B groups make up almost half of all groups.
Extending the Composite

Comparing observers back in time [that overlap first our composite and then each other] one can extend the composite successively back to Schwabe:

There is now no systematic difference between the Zurich SSN and a Group SSN constructed by not involving RGO.
Geomagnetic Calibration of Sunspot Numbers
Wolf’s Several Lists of SSNs

- During his life Wolf published several lists of his ‘Relative Sunspot Number’:
  - 1857 Using Sunspot Drawings By Staudacher 1749-1799 as early SSNs
  - 1861 Doubling Staudacher’s Numbers to align with the large variation of the ‘Magnetic Needle’ in the 1780s
  - 1874 Adding newer data and published new list
  - 1880 Increasing all values before his own series [beginning 1849] by ~25% based on Milan Declination
  - 1902 [Wolfer] reassessment of cycle 5 reducing it significantly, obtaining the ‘Definitive’ List in use today
Geomagnetic Regimes

1) Solar FUV maintains the ionosphere and influences the daytime field.
2) Solar Wind creates the magnetospheric tail and influences mainly the nighttime field
Justification of the Adjustments rests on Wolf’s Discovery: \( rD = a + b R_W \)

\[
\begin{align*}
Y &= H \sin(D) \\
dY &= H \cos(D) \, dD
\end{align*}
\]

For small \( D, \ dD \) and \( dH \)

A current system in the ionosphere [E-layer] is created and maintained by solar FUV radiation. Its magnetic effect is measured on the ground.
10 Days of geomagnetic variations

![Graph showing geomagnetic variations over 10 days. The graph displays fluctuations in magnetic field strength, with arrows indicating significant changes. The X-axis represents time (20nT/div), and the Y-axis shows magnetic field strength.]
The Diurnal Variation of the Declination for Low, Medium, and High Solar Activity

Diurnal Variation of Declination at Praha (Pruhonice)

Diurnal Variation of Declination at Praha

1957-1959
1964-1965
1840-1849
rD
Using $rY$ from nine ‘chains’ of stations we find that the correlation between $F10.7$ and $rY$ is extremely good (more than 98% of the variation is accounted for).

This establishes that Wolf’s procedure and calibration are physically sound.
Wolf got Declination Ranges for Milan from Schiaparelli and it became clear that the pre-1849 SSNs were too low.

The ‘1874’ list included the 25% [Wolf said 1/4] increase of the pre-1849 SSN.
The Wholesale Update of SSNs before 1849 is Clearly Seen in the Distribution of Daily SSNs

The smallest non-zero SSN is 11, but there are no 11s before 1849

11 * 5/4 = 14
Wolf’s SSN was thus now consistent with his many-station compilation of the diurnal variation of Declination 1781-1880.

It is important to note that the relationship is linear for calculating averages.
Wolfer’s Revision of Solar Cycle 5 Based on Observations at Kremsmünster

The Kremsmünster data is of very poor quality and consists of small sketches that were at times produced when there were notable spot activity.

We have precious little information about cycles 5 and 6. Those two cycles are on the target list for the next SSN workshop.
The Early ~1885 Discrepancy

• Since the sunspot number has an arbitrary scale, it makes no difference for the calibration if we assume Rg to be too ‘low’ before ~1885 or Rz to be too ‘high’ after 1885

By applying Wolf’s relationship between Rz and the diurnal variation of the Declination we can show that it is Rg that is too low
Adolf Schmidt’s (1909) Analysis

Schmidt collected raw hourly observations and computed the first four Fourier components [to 3-hr resolution] of the observed Declination in his ambitious attempt to present what was then known in an ‘einheitlicher Darstellung’ [uniform description].

Engelenburg and Schmidt calculated the average variation over the interval for each month and determined the amplitude and phase for each month. From this we can reconstruct the diurnal variation and the yearly average amplitude, dD [red curve].
Procedure:
For each station we now compute the averages over the interval of \( <R_z> \), of \( <R_g> \), and of the diurnal range [converted to force units, nT, from arc minutes] and plot The Group Sunspot Numbers \( <R_g> \) as blue and red squares. It is clear that \( <R_g> \)s for the early interval fall significantly and systematically below \( <R_g> \) for the later.

Increasing the early \( <R_g> \)s by 40% brings them into line with \( <R_z> \) before Waldmeier (Circles with dots).

We conclude that the early Group Sunspot Numbers are too low, consistent with our analysis of the K-factors.
Helsinki-Nurmijärvi Diurnal Variation

Helsinki and its replacement station Numijärvi scales the same way towards our composite of nine long-running observatories and can therefore be used to check the calibration of the sunspot number (or more correctly to reconstruct the F10.7 radio flux)

Scaling to 9-station chain

rY '9-station Chain'

\[ y = 1.1254x + 4.5545 \]

\[ R^2 = 0.9669 \]
The HLS-NUR data show that the Group Sunspot Number before 1880 must be increased by a factor $1.64 \pm 0.15$ to match $rY (F10.7)$. This conclusion is independent of the calibration of the Zürich SSN, $R_z$. 
Wolf’s Original Geomagnetic Data

Wolf found a very strong correlation between his Wolf number and the daily range of the Declination.

Wolfer found the original correlation was not stable, but was drifting with time and gave up on it in 1923.

Today we know that the relevant parameter is the East Component, Y, rather than the Declination, D. Converting D to Y restores the stable correlation.
Using the East Component We Recover Wolf’s Tight Relationship

The regression lines are identical within their errors before and after 1883.0. This means that likely most of the discordance with $R_g \sim 1885$ is not due to ‘change of guard’ or method at Zürich. It is also clear that $R_g$ before 1883 is too low.
The dependence of the coupled magnetosphere-ionosphere-thermosphere system on the Earth’s magnetic dipole moment

Ingrid Cnossen,\textsuperscript{1} Arthur D. Richmond,\textsuperscript{1} and Michael Wiltberger\textsuperscript{1}

[39] Svalgaard [2009] noted that in particular the eastward component of the daily Sq variation is a useful indicator of solar activity, and may be used as a tool to calibrate the long-term sunspot number record. Clearly, if geomagnetic data are to be used in this way, the effects of the decreasing dipole moment on Sq variation must be considered and corrected for. Our scaling relations will be a first tool to do so, although local changes in the magnetic field over specific stations could also be important.
Putting the discovery to work

Variations of F10.7 microwave flux and Ca II K-line index (and thus solar activity) track the Diurnal Variation of the Geomagnetic Field.
Putting the discovery to work

Variations of F10.7 microwave flux and Ca II K-line index (and thus solar activity) track the Diurnal Variation of the Geomagnetic Field.

Overlay shows Peter Foukal’s Ca II index scaled to fit.
What to do about all this?

The implications of this re-assessment of the sunspot record are so wide-ranging that the SSN community has decided on a series of Workshops to solidify this.

We have a Wiki giving details and presentations: http://ssnworkshop.wikia.com/wiki/Home

The goal is to arrive at a single, vetted series that we all agree on.

The SSN workshops are sponsored by the National Solar Observatory (NSO), the Royal Observatory of Belgium (ROB), and the Air Force Research Laboratory (AFRL).
Prediction of Future Activity

- Polar Fields Precursor
- Livingston & Penn Effect
- Grand Minima?

“It is difficult to predict, especially the future”
Polar Field Precursor

North - South Solar Polar fields [microTesla]

Solar Dipole Divided by Sunspot Number for Following Maximum

Active Region Count

Numbered Active Regions per Month
But is the SSN Always a Good Measure of Solar Activity?

Since ~1990 we record progressively fewer sunspots than expected from observations of F10.7 microwave flux.
We Observe a Deficit of Small Spots

Lefevre & Clette, SIDC
We see fewer sunspots for given MPSI.

MPSI is the sum the absolute values of the magnetic field strengths for all pixels where that value is between 10 and 100 gauss. The sum is then divided by the total number of pixels in the magnetogram.
We Observe
Fewer Spots per Sunspot Group

There is a weak solar cycle variation on top of a general downward trend seen by all observers. We are losing the small spots. What could be the cause of that?
The Livingston & Penn Data

From 1998 to 2012 Livingston and Penn have measured field strength and brightness at the darkest position in umbrae of 3148 spots using the large Zeeman splitting of the infrared Fe 1564.8 nm line.
Spot Umbral Intensity [Temperature] and Magnetic Field Changing
Sunspots form by assembly of smaller patches of magnetic flux. As more and more magnetic patches fall below 1500 G because of the shift of the distribution, fewer and fewer visible spots will form as observed.
What to Predict? What to Use?

- So when predicting the solar cycle, do we predict F10.7 [or Ca II or MSPI or similar]
- Or should we predict SSN?
- As these diverge from each other, which is the ‘real’ activity?
- What do we do if SSN falls to near zero [while F10.7 does not] during the next cycle(s)?
- Is this how it was during the Maunder Minimum? [when the cycle was still operating and cosmic rays were still modulated. Magnetism was there, without the spots]
Cosmic Ray Proxy [Berggren et al.]
‘Burning Prairie’ => Magnetism

Figure 1 An early drawing of the “burning prairie” appearance of the Sun’s limb made by C.A. Young, on 25 July 1872. All but the few longest individual radial structures are spicules.

It is now well known (see, e.g., the overview in Foukal, 2004) that the spicule jets move upward along magnetic field lines rooted in the photosphere outside of sunspots. Thus the observation of the red flash produced by the spicules requires the presence of widespread solar magnetic fields. Historical records of solar eclipse observations provide the first known report of the red flash, observed by Stannyan at Bern, Switzerland, during the eclipse of 1706 (Young, 1883). The second observation, at the 1715 eclipse in England, was made by, among others, Edmund Halley – the Astronomer Royal. These first observations of the red flash imply that a significant level of solar magnetism must have existed even when very few spots were observed, during the latter part of the Maunder Minimum.

Foukal & Eddy, Solar Phys. 2007, 245, 247-249
Conclusions

- Wolf [International] SSN must be corrected by +20% prior to ~1945
- Group SSN should be abandoned and the data incorporated/merged with the Wolf SSN to a new standard
- The geomagnetic record can be used to calibrate/cross-check the early data
- No Modern Grand Maximum
- Meaning of the SSN in future is uncertain
Abstract

A hundred years after Rudolf Wolf’s death, Hoyt et al. (1994) asked “Do we have the correct reconstruction of solar activity?” After a heroic effort to find and tabulate many more early sunspot reports than were available to Wolf, Hoyt et al. thought to answer that question in the negative and to provide a revised measure of solar activity, the Group Sunspot Number (GSN) based solely on the number of sunspot groups, normalized by a factor of 12 to match the Wolf numbers 1874–1991. Implicit in that normalization is the assumption or stipulation that the ‘Wolf’ number is ‘correct’ over that period. In this talk we shall show that that assumption is likely false and that the Wolf number (WSN) must be corrected. With this correction, the difference between the GSN and WSN becomes even more disturbing: The GSN shows either a ‘plateau’ until the 1940s followed by a Modern Grand Maximum [MGM], or alternatively a steady rise over the past three hundred years, while the (corrected) WSN shows no significant secular trend and no MGM. As the sunspot number is often used as the basic input to models of the future evolution of the Earth’s environment and of the climate, having the correct reconstruction becomes of utmost importance, and the difference between GSN and WSN becomes unacceptable. By re-visiting the construction of the GSN we show how the GSN can be reconciled with the WSN, resolving the issue. We finally report on recent discrepancies between various indices of solar activity which raise the issue of the very meaning of the sunspot number and of the future evolution [and predictability] of solar activity. The talk is based on work in support of the Sunspot Number Workshops: http://ssnworkshop.wikia.com/wiki/Home