The SONNE Sunspot Number Network – 35 Years & Counting

Andreas Bulling, Germany

VdS solar section

Solar Section

Solar section „Fachgruppe Sonne“ is organized as part of the german amateur society „Vereinigung der Sternfreunde“ (VdS)

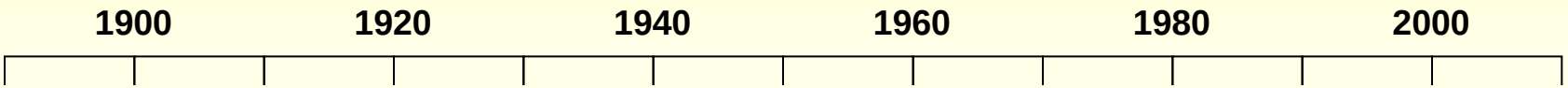
- **More than collecting Wolf numbers**
- **Supports local observer groups**
- **Open structure, no membership, broad spectrum of people**
- **Dynamic organizer team, good mix of experienced observers and young (physics) students**

SONNE network

“SONNE network” refers more to active observers and the different observation programs, especially to Wolf number observations

- **Open for every observer**
- **Most data sent by amateurs, also important contributions from observatories**
- **Several observation programs, mainly Wolf number but also other indices (Beck, Pettis, Faculae, naked eye), Hα, photography, position measurements, rotation law etc.**
- **Cooperation with other networks / observers globally**
- **Founded together with SONNE journal 1977 in West Germany**
- **Tasks: Collection and evaluation of observations, publication**

Amateur solar observer groups in Germany



1891: First solar observers group in Germany (Wilhelm Foerster)

1917 - 1966 Solar section **DARGESO** within amateur society GEDELIA.
1946-1966: 10-30 observers, >40k observations.

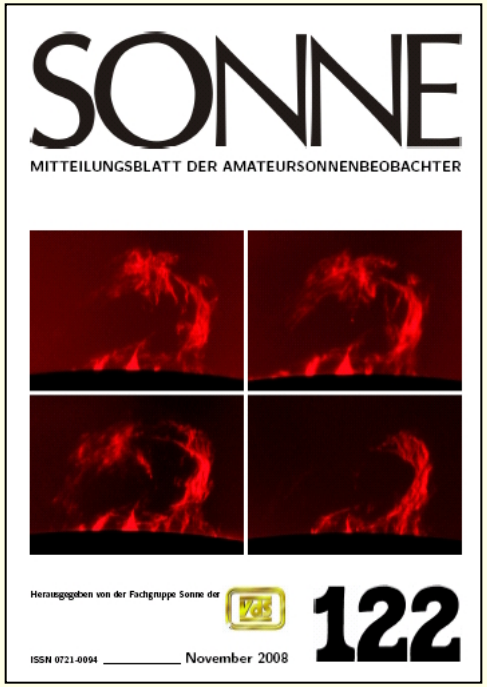
1969: Solar section of VdS (West Germany) founded

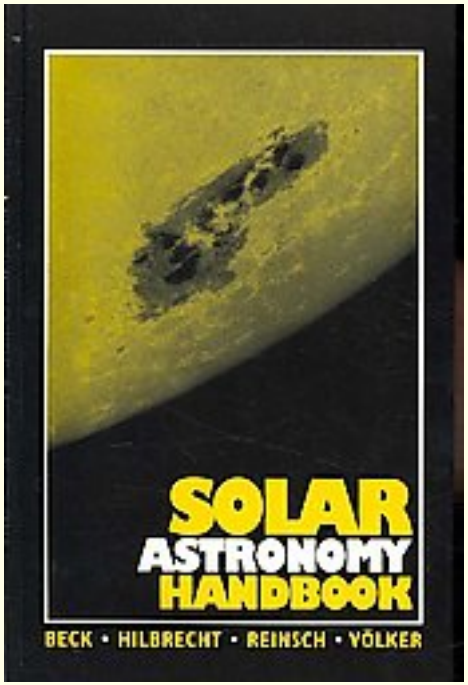
1977: SONNE journal founded (→ „**SONNE network“**)
1977-2012: 50-150 observers, 500k observations

1977 (-1990): **AKS** within „Kulturbund“ (German Democratic Republic)
Around 70 observers

Solar section / SONNE network activities

- **Journal „SONNE“: results, articles, forum for observers**
- **Articles and handouts for VdS or wider public**
- **Other publications; „Solar Astronomy Handbook“**
- **Yearly meeting and workshops for exchange of ideas and methods**
- **Contact:**
  Michael Delfs, Berlin
- **www.vds-sonne.de**





SONNE network – history of evaluation

Year	Data available	Evaluation
1947-59	~500 (single observers)	-
1974	~1500 / year	manual within local groups
1977	~4000 / year	R. Kayser

- One standard observer with known k-factor to Zürich (Mr. Bruns)
- Calibration of observers to standard observer

1979	~6000 / year	K. Reinsch
1982	>10’000 / year	K. Reinsch (new method)

- Stable observers chosen yearly as “Standard Observers”
- Quarterly evaluation, completely independent

1992-	>10’000 / year	G. Piehler, A. Zunker, A. Bulling

- Method still unchanged since 1982
- Low minimum 2009 makes new method mandatory

Observers worldwide, mainly in Europe

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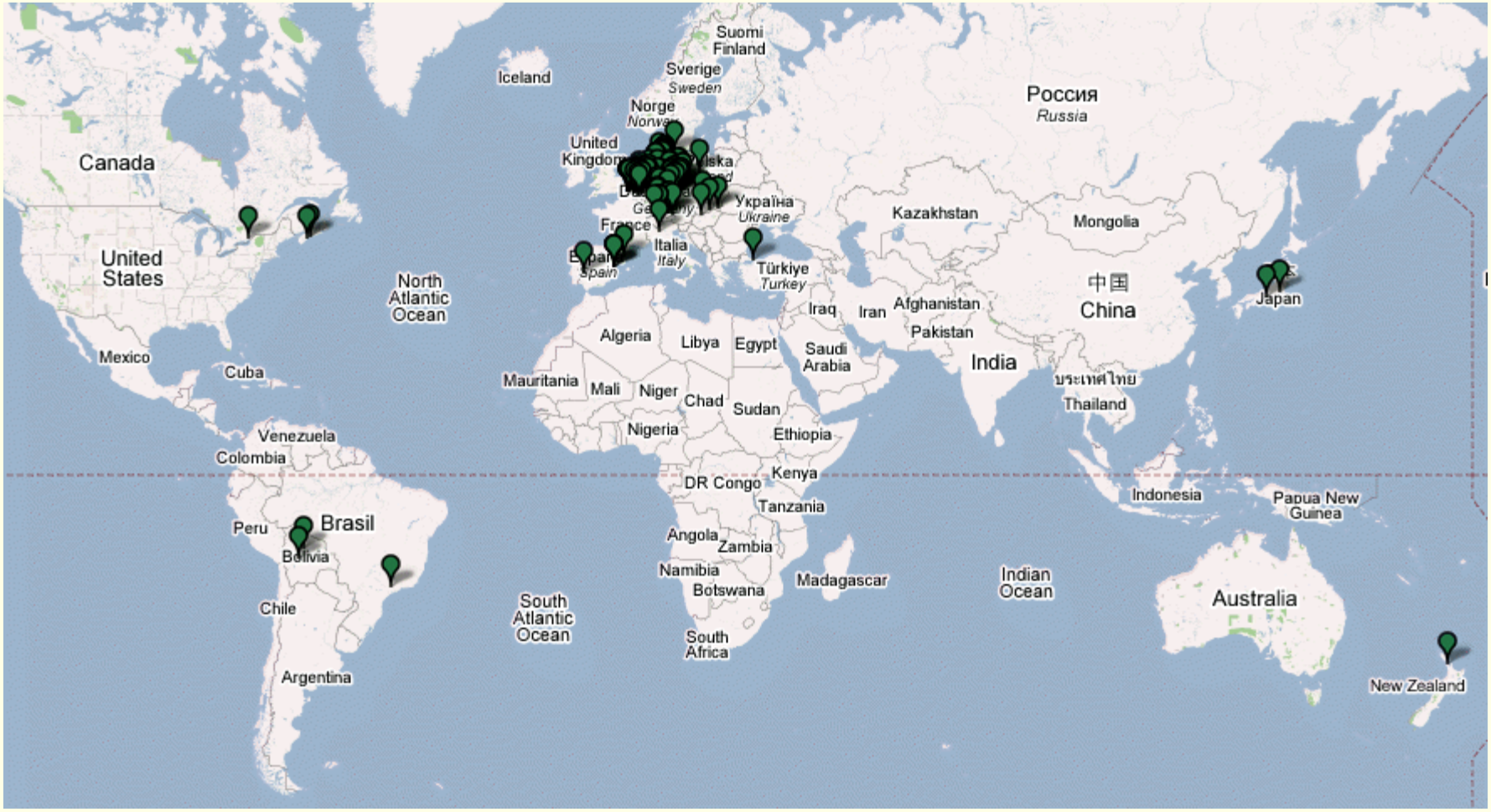
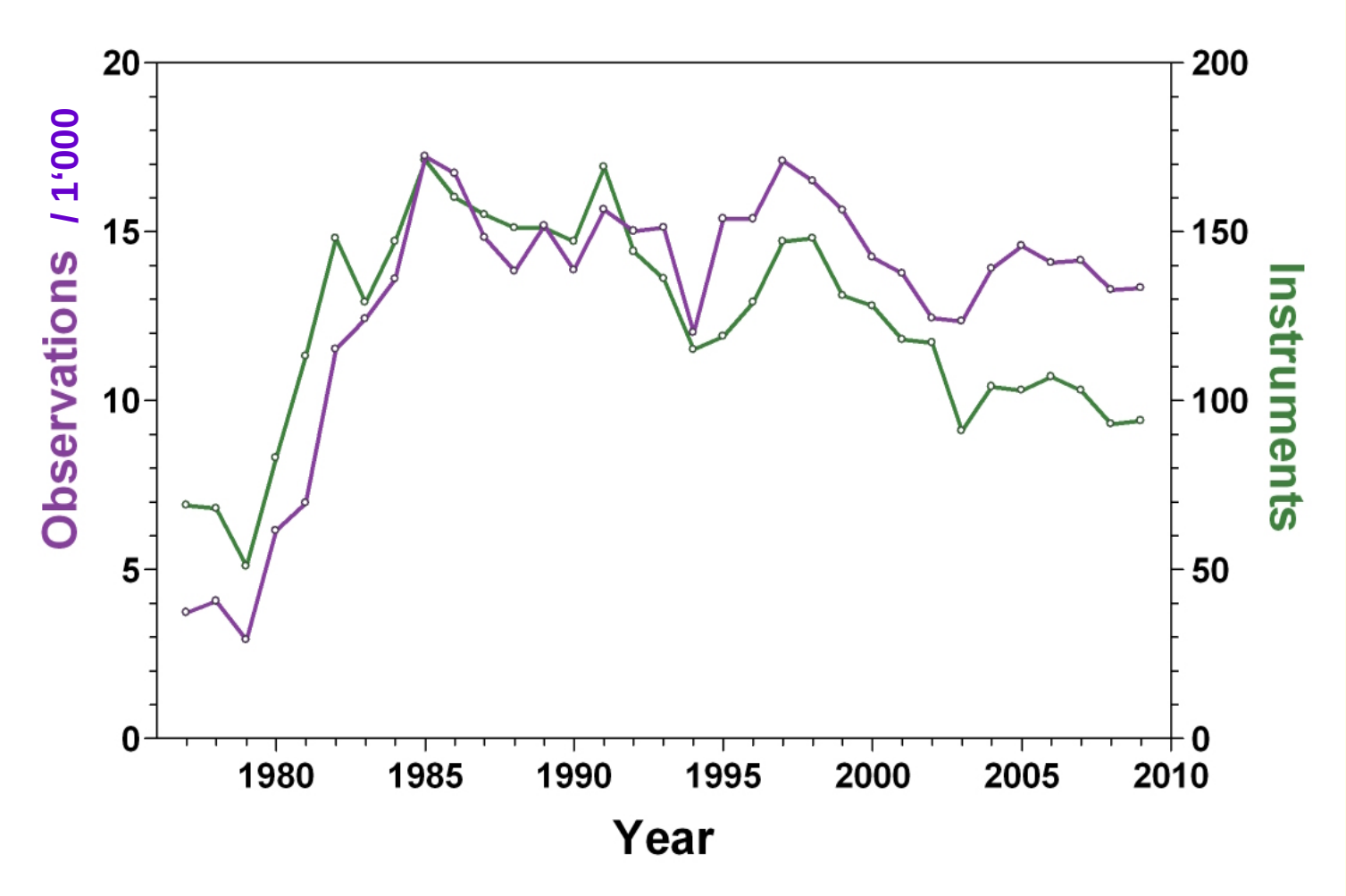


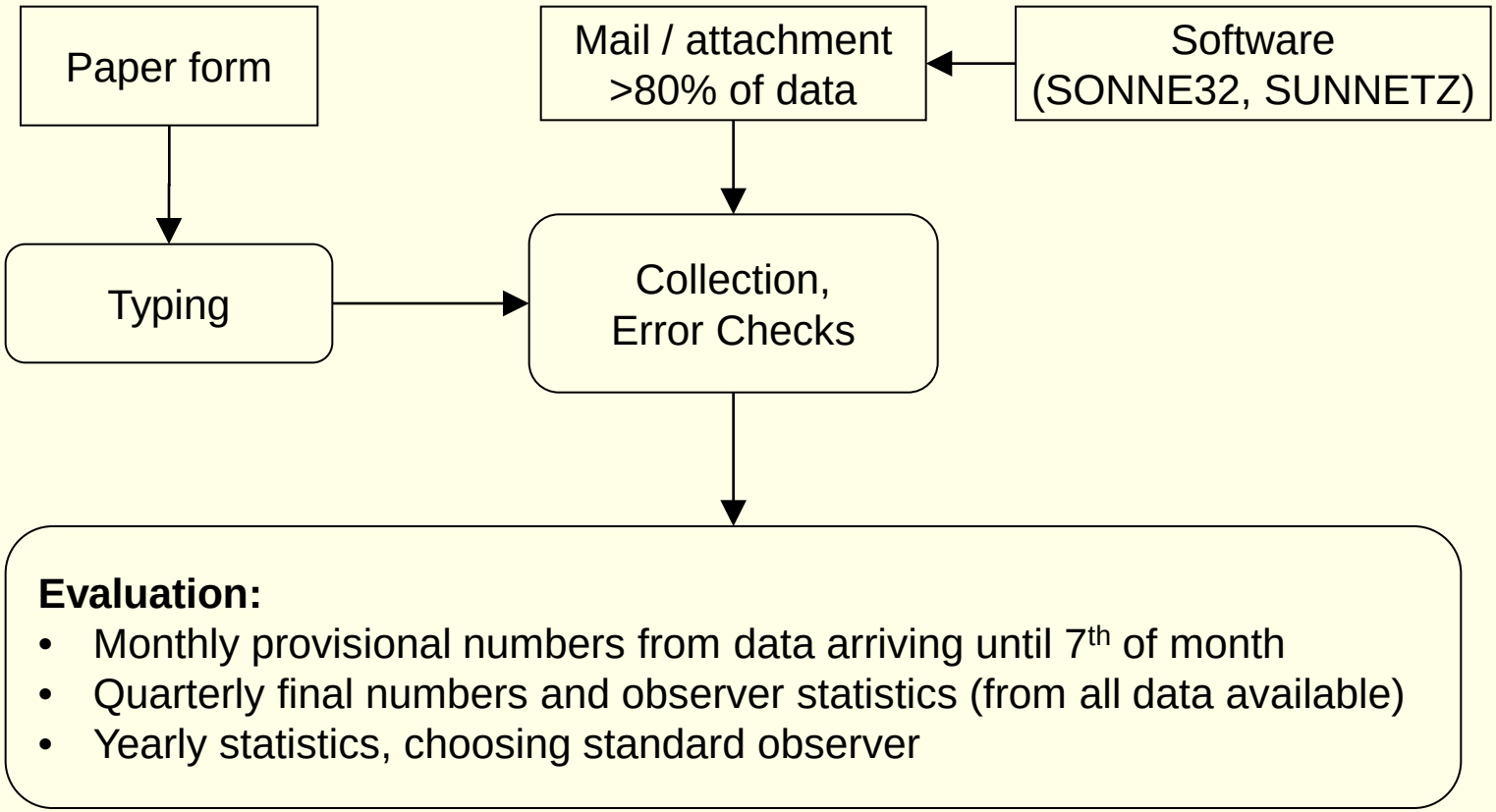
Number of participants



Observation regulatory

- **Recommended (not mandatory) instrument diameter > 40 mm**
- **All methods welcome (direct, photographic, projection)**
- **Observers should stick to common practice (no pores, constant counting method etc.)**
- **No special restrictions – if data are bad, they may be omitted (only 1 case in 20 years)**
- **Hemispheric data may be discarded from non-experienced obervers / used only from position measurements**

Observation data collection and evaluation

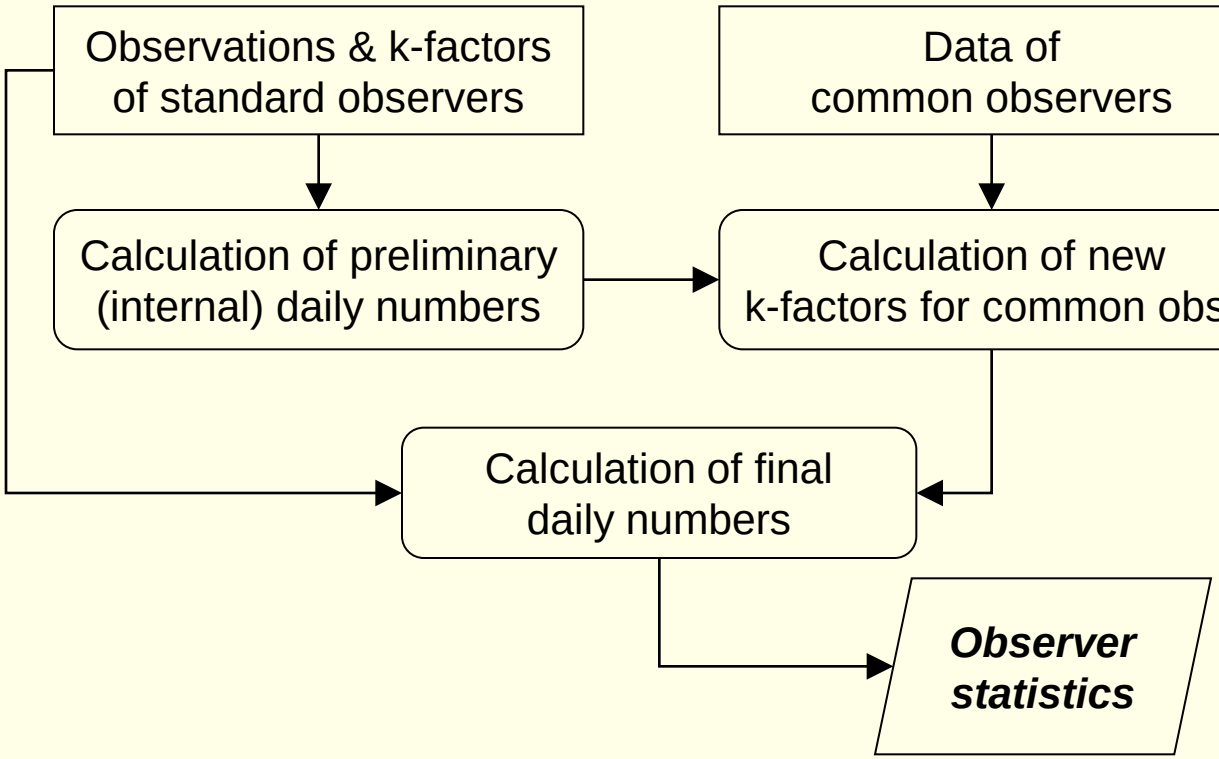


SONNE network – evaluation method (1982 – 2008)

- **Description: SONNE 16, No. 62, p. 57-60; based on analysis by E. Karkoschka, 1982.**
- **Two observer groups: Normal / common and standard / ”high quality” observers.**
- **Independent of other series, therefore common observers have to be calibrated to provisional numbers calculated in advance from data of experienced “standard observers”.**
- **k-factor of standard observers are constant for 1 year.**
- **One-time calibration of network: Standard observer k-factors for 1982 were calculated as mean of yearly k-factors 1980 and 1981.**
- **System is more “democratic” than previous one, where single main observer determined numbers, others to fill gaps only.**
- **Common observers have limited short-range influence.**

Quarterly evaluation

- **Calculation of actual daily numbers (R and g independently)**
- **Re-calibration of common observers**
- **List of observers with k-factors and quality criteria**



$$k_{Quart} = \frac{\sum_i \left(\mathrm{Re}_{prel}\right)_i}{\sum_i \left(\mathrm{Re}_{Obs}\right)_i}$$

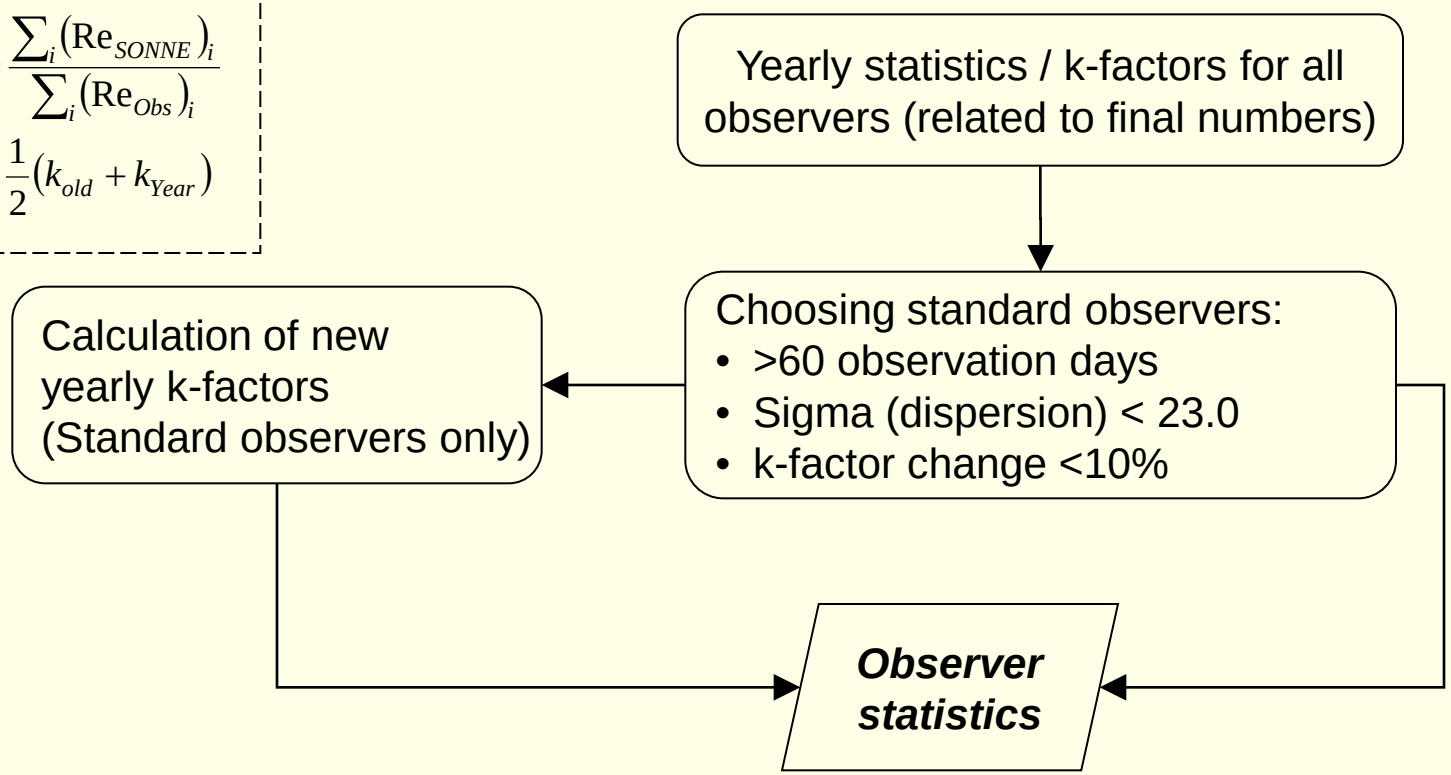
$$k_{new} = \frac{1}{2}\left(k_{old} + k_{Quart}\right)$$

Yearly evaluation

- **Re-calibration and choosing of standard observers**
- **List of observers with k factors and quality criteria (last year)**

$$k_{Year} = \frac{\sum_i (\mathrm{Re}_{SONNE})_i}{\sum_i (\mathrm{Re}_{Obs})_i}$$

$$k_{new} = \frac{1}{2}(k_{old} + k_{Year})$$



Observer statistics (yearly evaluation)

	Name	Instrument	Obs.days tot.	N/S	RB	k-Factors R	g	RB	sigma R	r R
	Arndt,D.	Refr. 150/2250	**48**	0	0	**0.327**	0.458	-	**16**	0.81
+	Bachmann,U.	Refl. 203/2000	**67**	0	67	**0.637**	0.718	0.729	**12**	0.93
	Boschat,M.	Refr. 120/1000	**27**	0	0	**0.864**	0.835	-	**22**	0.78
	Brettel,G.	Refr. 90/1000	**168**	0	0	**0.709**	0.729	-	**11**	0.95
	Bulling,A.	Refl. 70/1000	**8**	0	8	**1.119**	1.225	1.062	**27**	0.68
	Bullon,J.M.	Refr. 102/1000	**47**	0	0	**0.488**	0.606	-	**15**	0.92
	Bullon,J.M.	Refr. 150/ 750	**29**	0	0	**0.623**	0.753	-	**21**	0.92
	Capricornio Obs.	Refr. 102/1500	**140**	0	0	**0.608**	0.670	-	**15**	0.93
(+)	Carels	Refr. 150/1200	**107**	0	103	**0.700**	0.716	1.094	**13**	0.94
(+)	Claes,J.	Refr. 0/ 0	**210**	0	191	**0.701**	0.739	1.280	**11**	0.96
	DKS Eriskirch	Refr. 152/1824	**17**	0	0	**0.907**	0.817	-	**8**	0.95

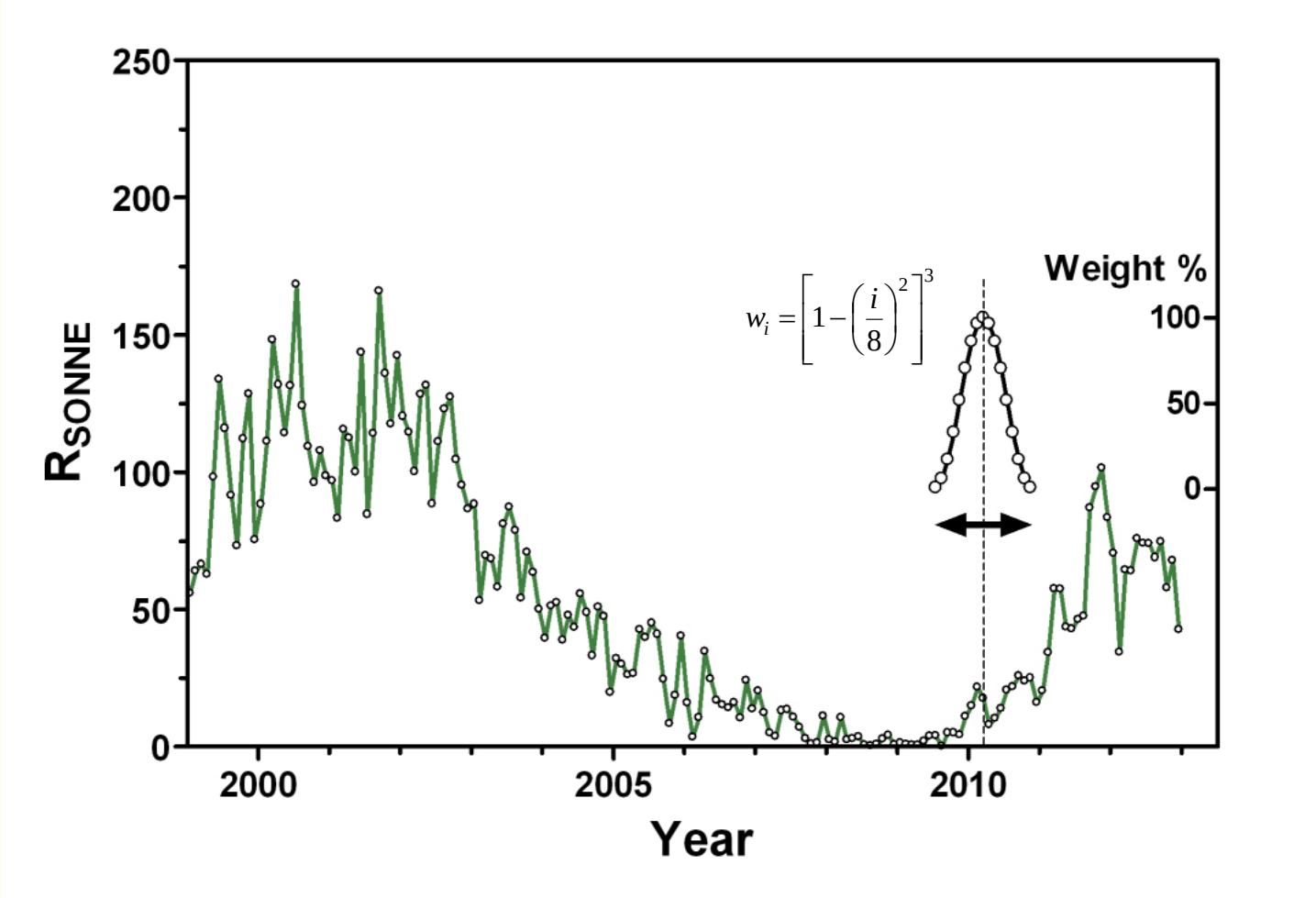
+ : New standard observer next year (criteria ok for 2 years)

(+) : Criteria ok last year (standard observer candidate)

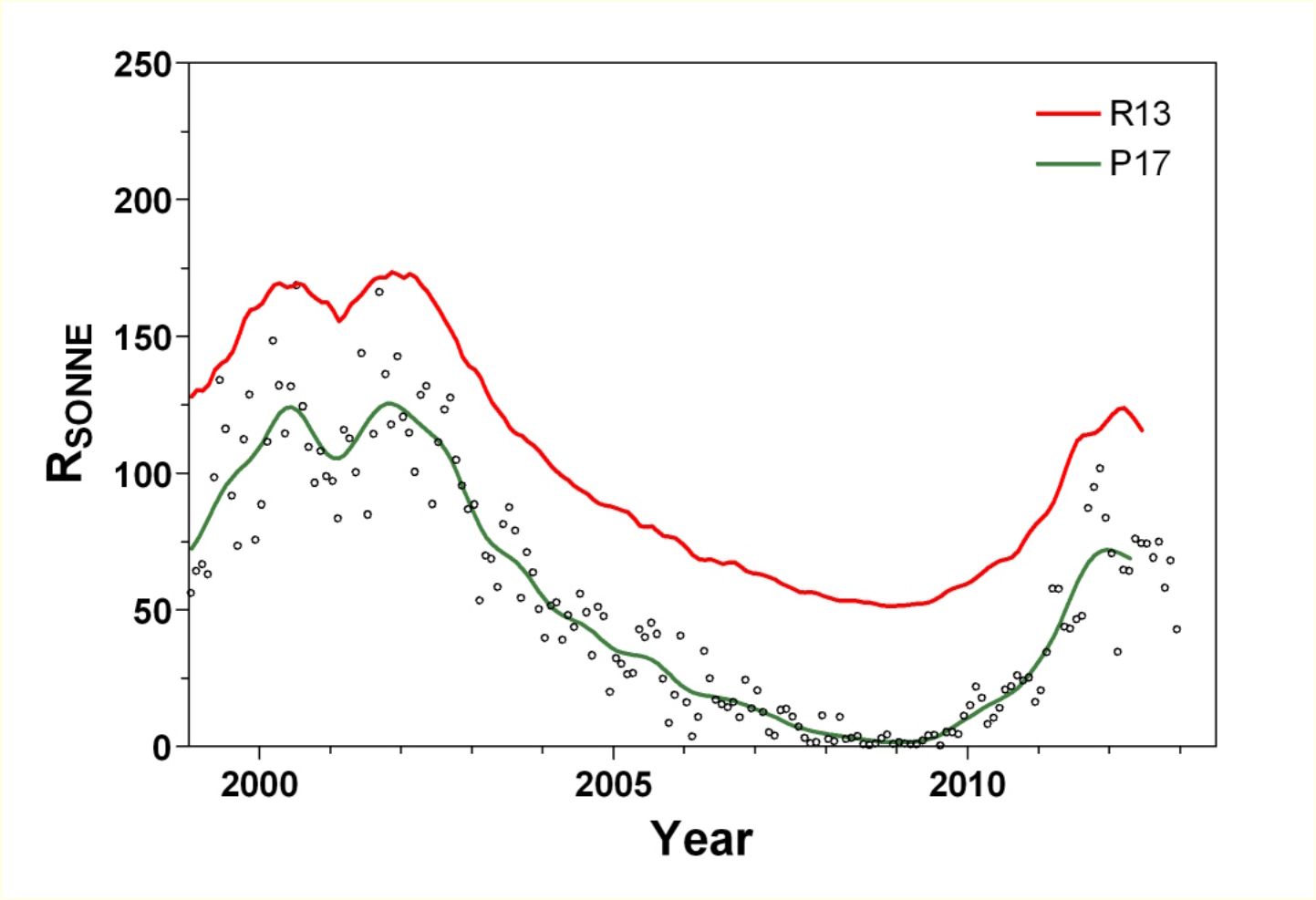
(-) : Standard observer criteria not ok last year

- : Common observer next year (criteria out-range for second year)

Wolf number smoothing

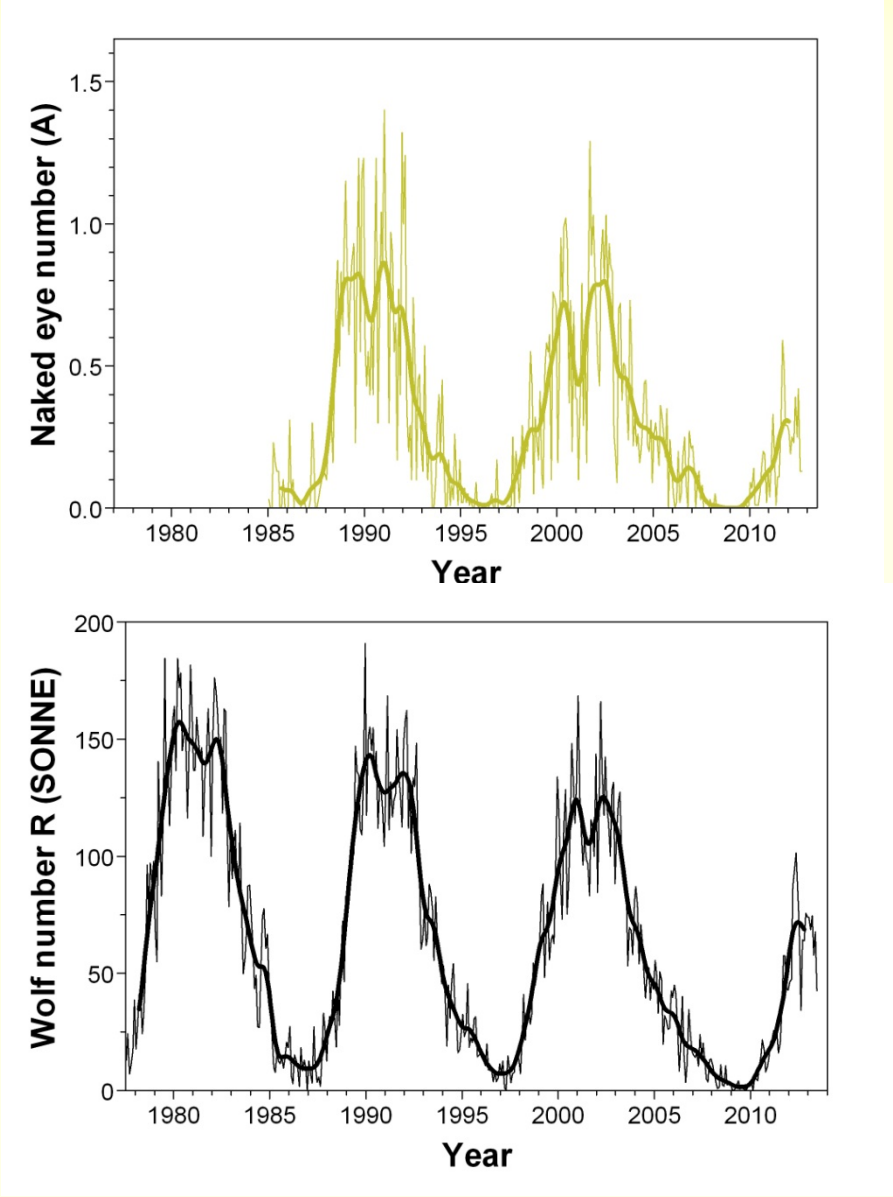


Wolf number smoothing – R13 vs. P17

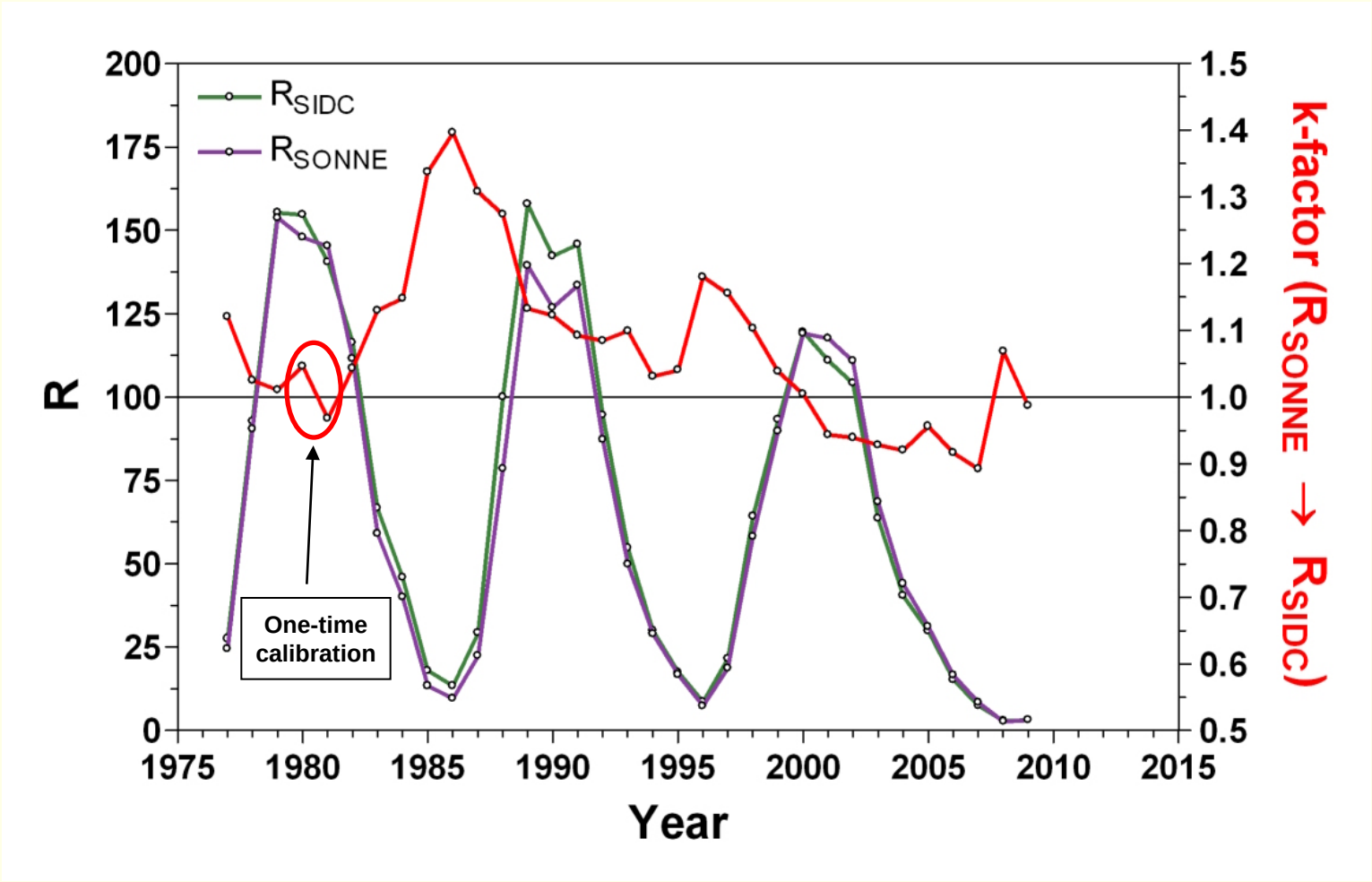


Naked eye observations

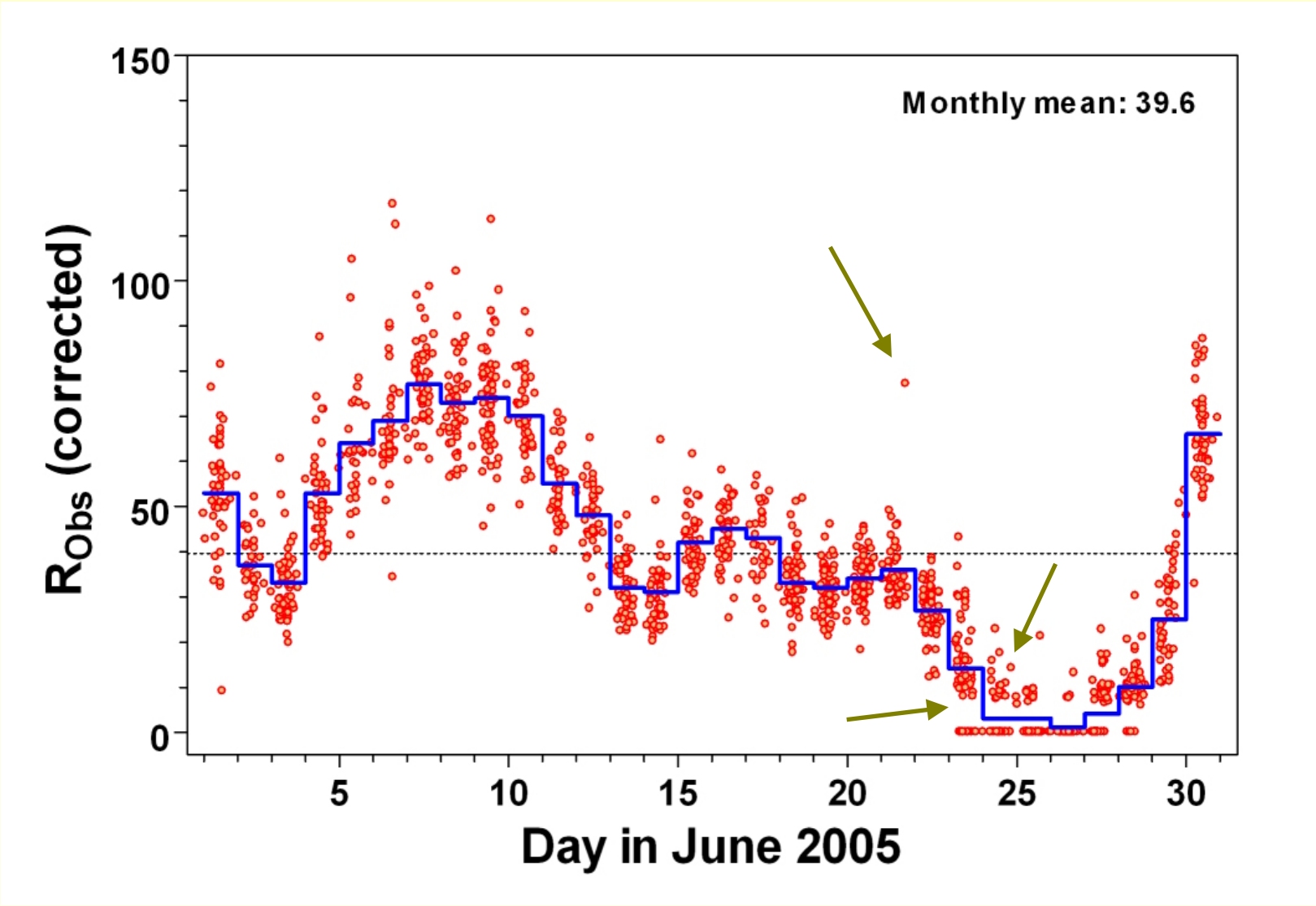
- **Started by H.U. Keller, Zürich, now evaluated by S. Fritsche**
- **Smoothed MM reflect Wolf number curve quite well**
- **Bridge to time before 1610?**



SONNE vs. SIDC data



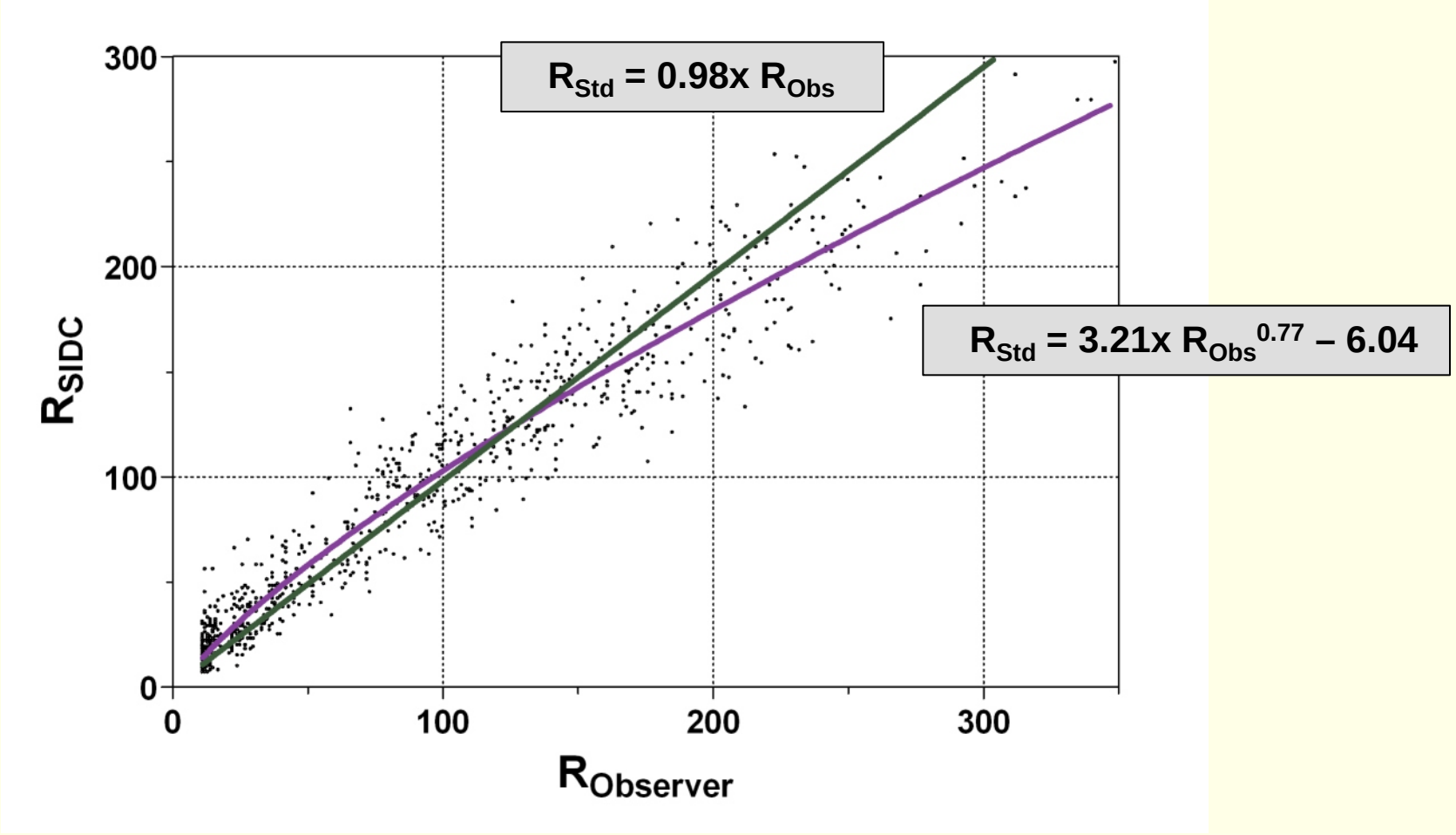
3 problems calculating daily SSN



Problems of SONNE network evaluation method

- **Daily R values are calculated as mean**
  - ➢ **Observations R = 0 pull value towards 0**
  - ➢ **Use only observations with R>0 on certain day, if another decision process hints to R>0**
- **Final daily R values contain extreme values / outliers**
  - ➢ **Influence on single values, increased variability**
  - ➢ **Use median instead of mean**
- **k-function is not a factor, sometimes not even linear**
  - ➢ **Drift of k-factors and R values compared to other networks**
  - ➢ **If drifting, a wrongful constant k for 1 year causes R drift**
  - ➢ **Use up to 3 types of k-functions, increase calibration range**

Evaluation – k-function vs. k-factor



The ~~Year 2000~~ ~~Dec 21 2012~~ R = 0 problem

- **2009: Very low minimum R values / long periods with R = 0**
  - ➢ **Not enough pairs with R > 0 for regression, correlation and dispersion not reasonable / evaluable**
  - ➢ **Increase time range for calibration / k-function**

SONNE Sunspot Network, Observers 3rd Quarter 2008

Name	Instrument	Obs.days tot.	N/S	RB	k-Factors R	g	RB	sigma R	r R
Brettel,G.	Refr. 90/1000	46	0	0	0.817	0.813	-	6	9.99
Bullon,J.M.	Refl. 200/2000	39	0	0	0.786	0.808	-	6	9.99
Bullon,J.M.	Refr. 102/1000	9	0	0	0.611	0.674	-	8	0.96
Bullon,J.M.	Refr. 120/1000	29	0	0	0.574	0.600	-	6	0.92
Bullon,J.M.	Refr. 150/ 750	9	0	0	0.691	0.810	-	0	9.99
Carels,J.	Refr. 150/1200	76	0	76	0.518	0.522	1.017	5	0.82
Claes,J.	Refr. 102/ 0	44	0	44	0.748	0.754	2.384	5	0.92
Claeys,L.	Refl. 158/ 0	65	0	0	0.422	0.433	-	11	0.49

SONNE network evaluation

- **Problem not solved yet, new method 90% ready, still testing**
- **Meanwhile: Provisional numbers with k-factors set constant (taken from yearly evaluation 2008)**

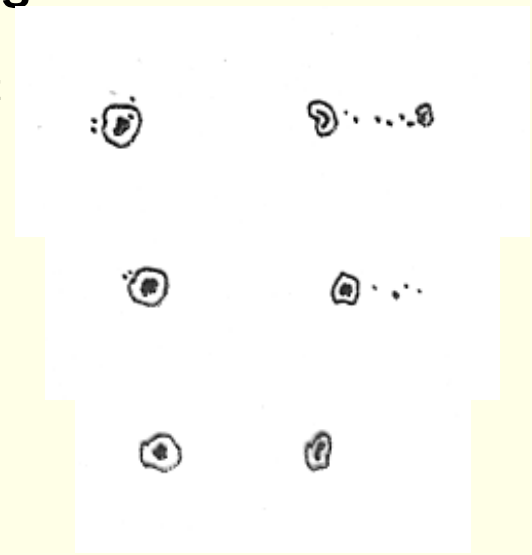
Pettis Index

- **Suggested by Hugh S. Pettis (USA), 1974**
- **SONNE observation program since 1982 (Martin Götz)**
- **SN = 10x p + s**
- **p = isolated penumbrae containing umbra(e); s = umbrae**
- **Regular evaluation until 1993, still 5-10 observers in 2012**

Pettis Index

Advantage 1: Pure counting => no grouping / classification problems

Development over days



2 groups, 13 spots, R=33

3 penumbrae, 9 umbrae, SN=39

2 groups, 8 spots, R=28

2 penumbrae, 6 umbrae, SN=26

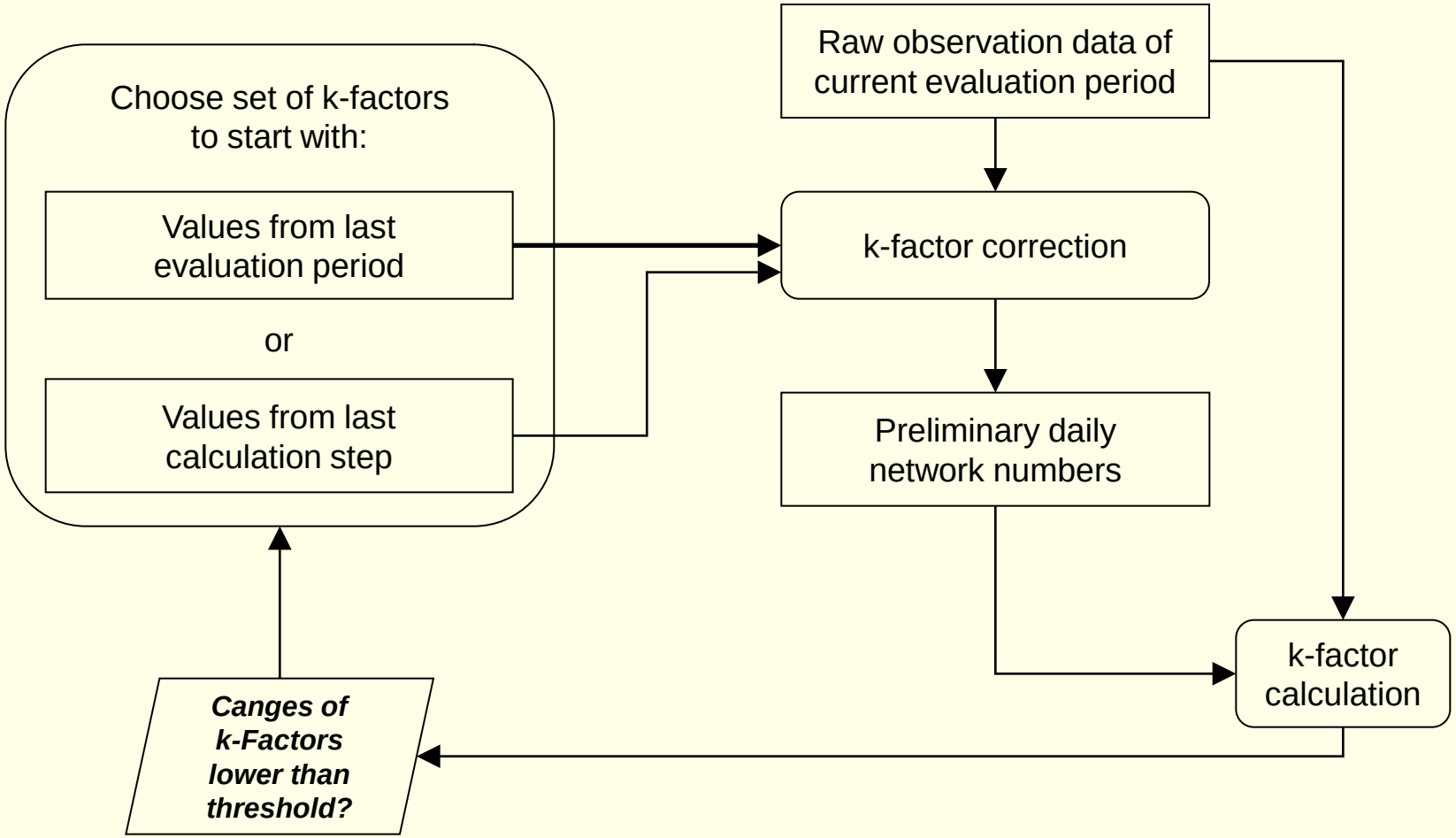
1 group or 2 groups, 2 spots, R=12 or R=22

2 penumbrae, 0 umbrae, SN=20

Advantage 2: p and s are independent, therefore no gap between SN = 0 and SN = 11

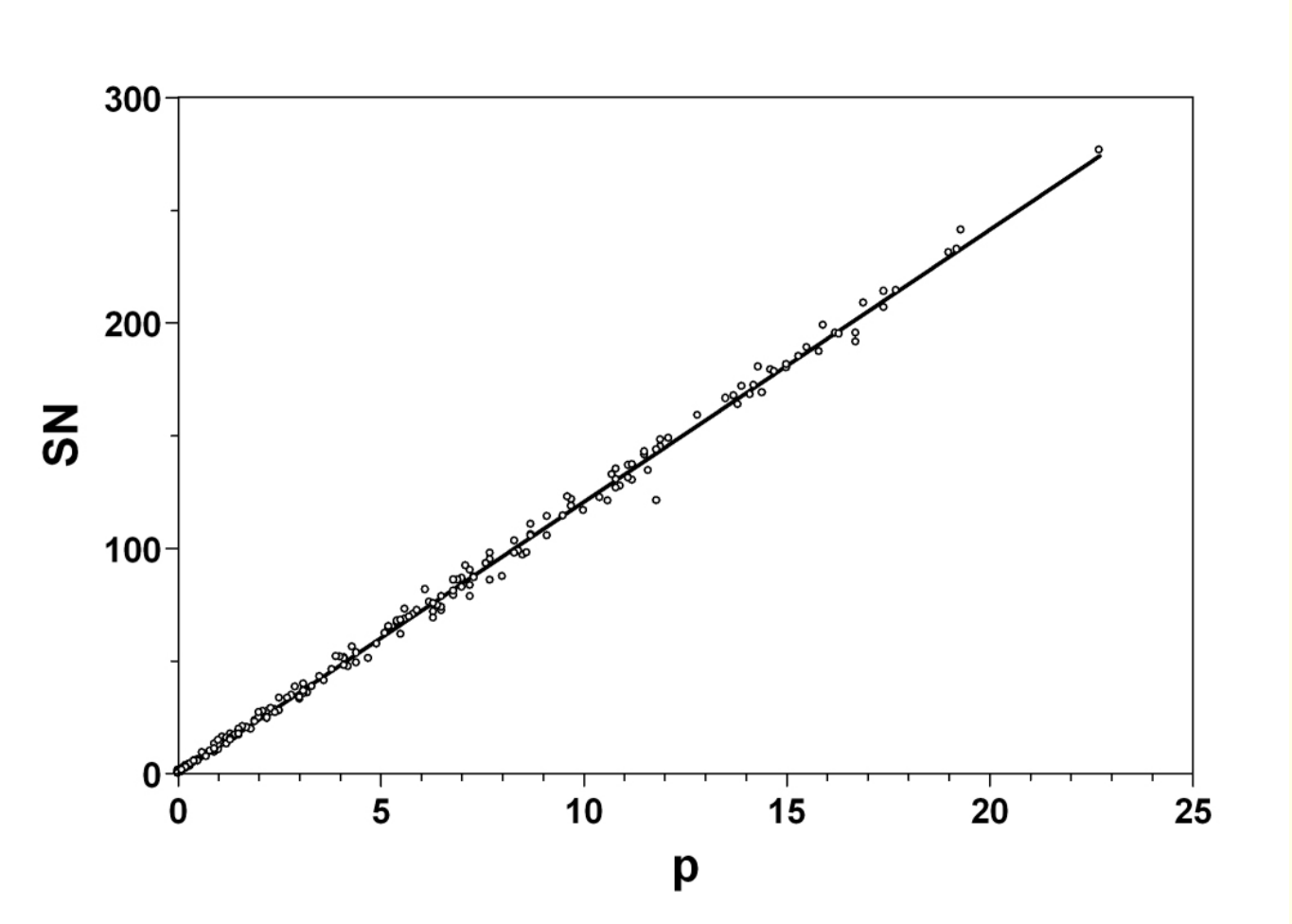
Pettis Index – Evaluation

Iterative method (adapted from M. Götz)



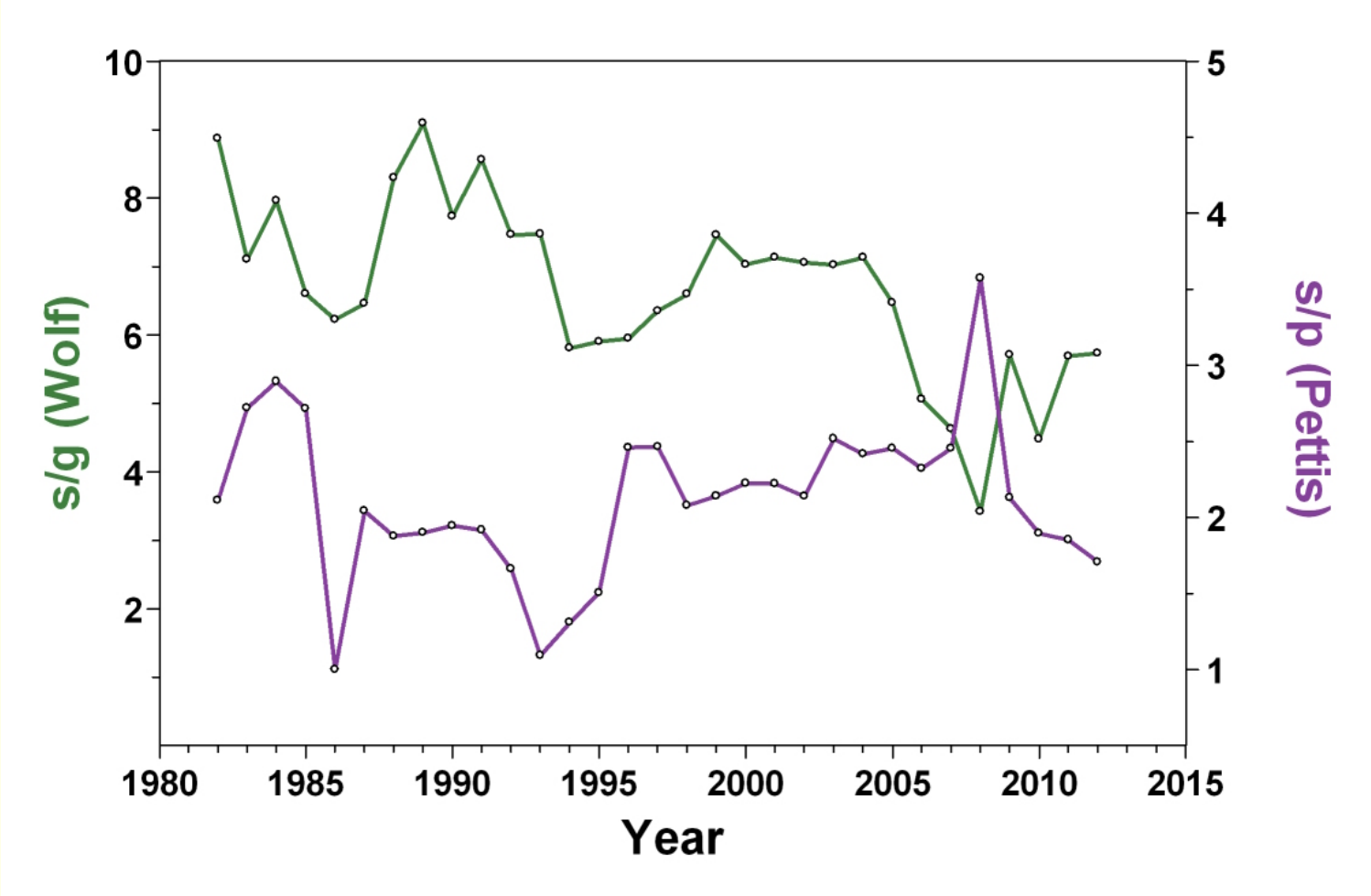
Pettis Index

SN = 12.07x p + 0.05 ; r = 0.999



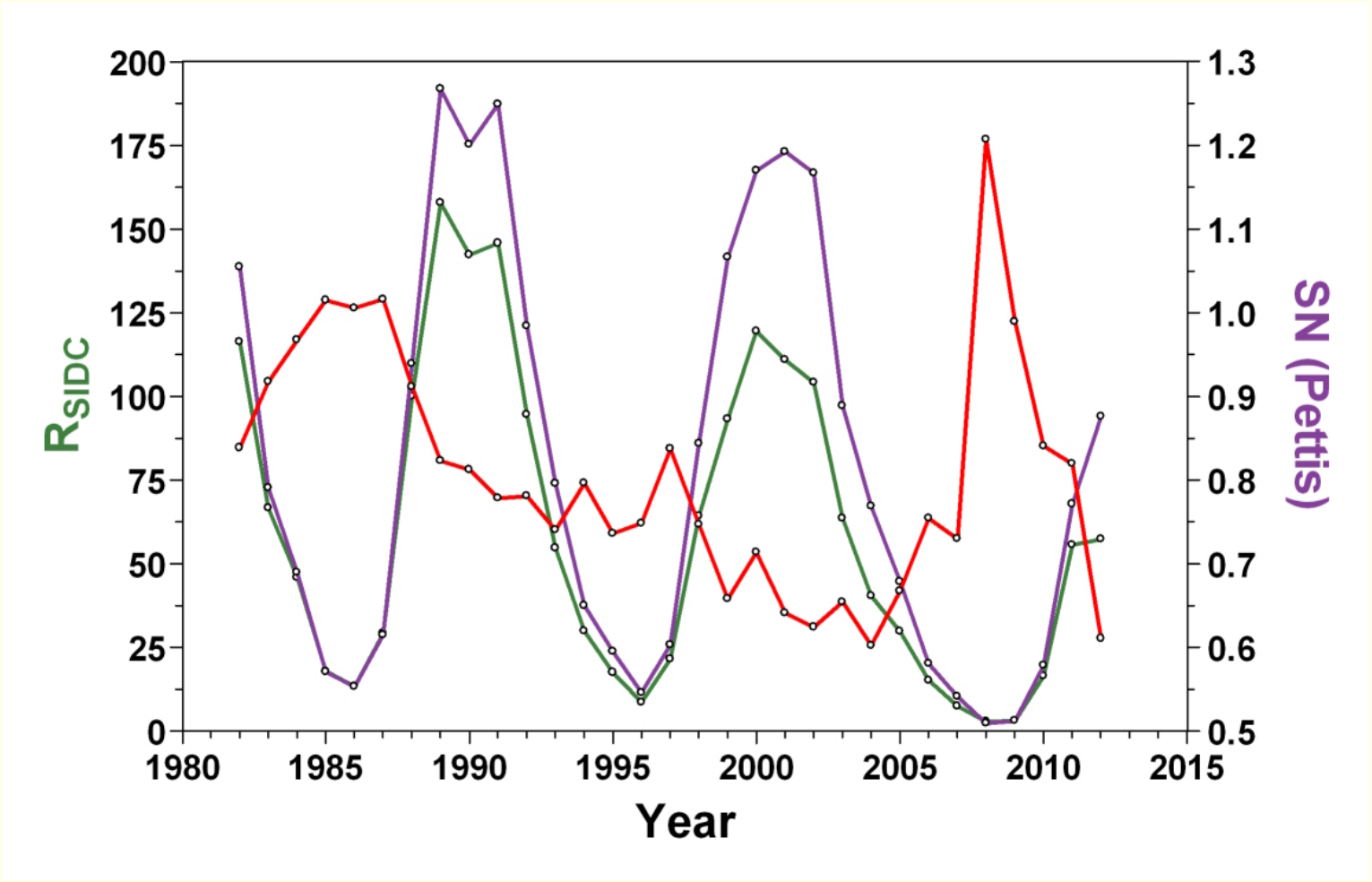
Pettis Index

Ratio s/p without dramatic change in 2005-2007 like s/g



Pettis Index

But caution … **[SN = 1.51x R – 3.13 ; r = 0.98]**



Thank you