

Sunspot Index and Group Number Reconstructions from 1949 until now

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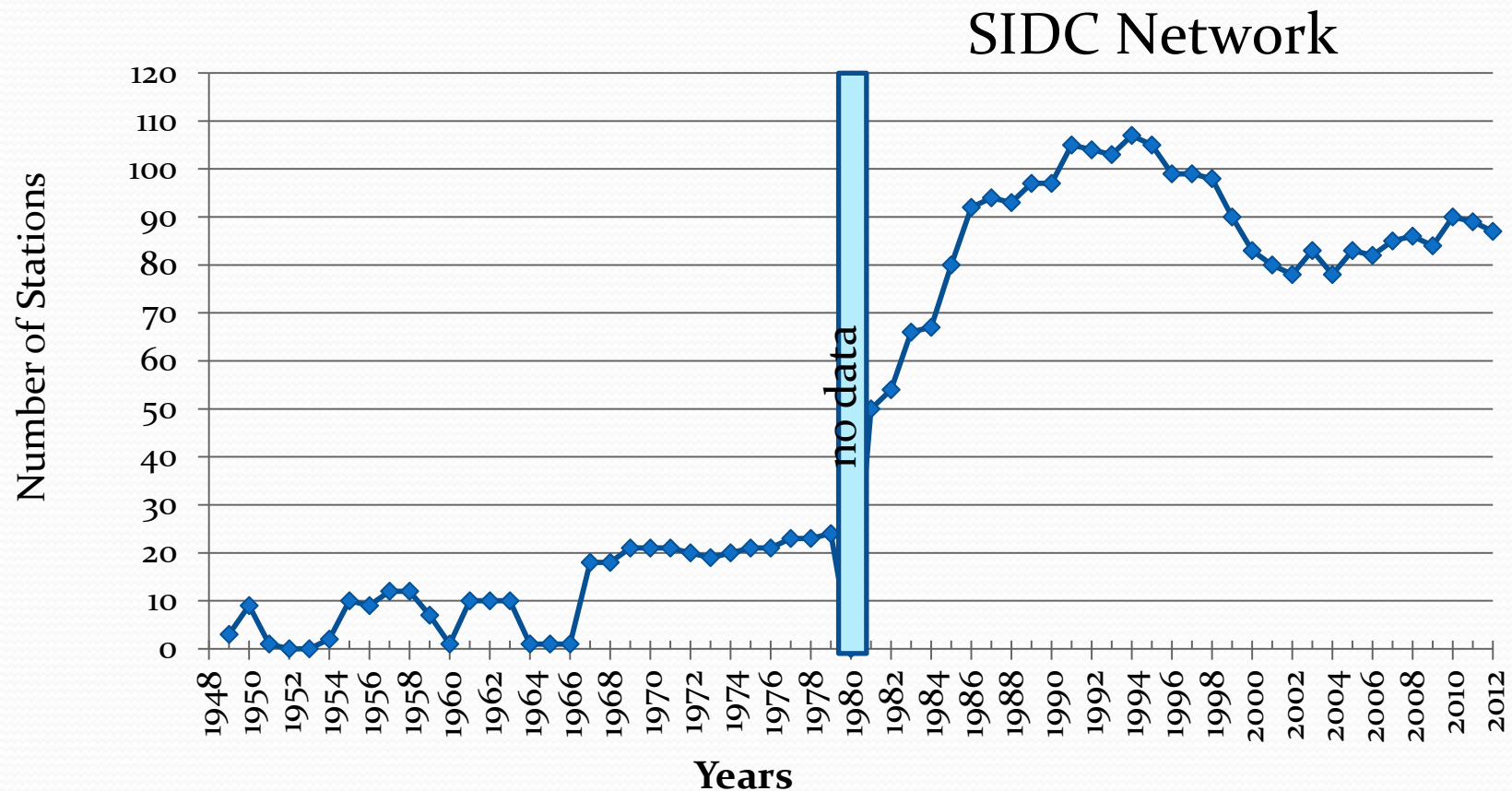
Royal Observatory of Belgium



Expansion of sunspot data set

- Since 2006, we collect sunspots data through a Web interface (<http://sidc.be/WOLF>)
- Database
 - Reported datasets per day and per stations
 - All data since 1981
 - We expanded the databases backwards for past years, from 1949 to 1980. From past reports, we choose stations which give us data from Zurich to the SIDC period.
 - More data from Zurich papers is still to be encoded.

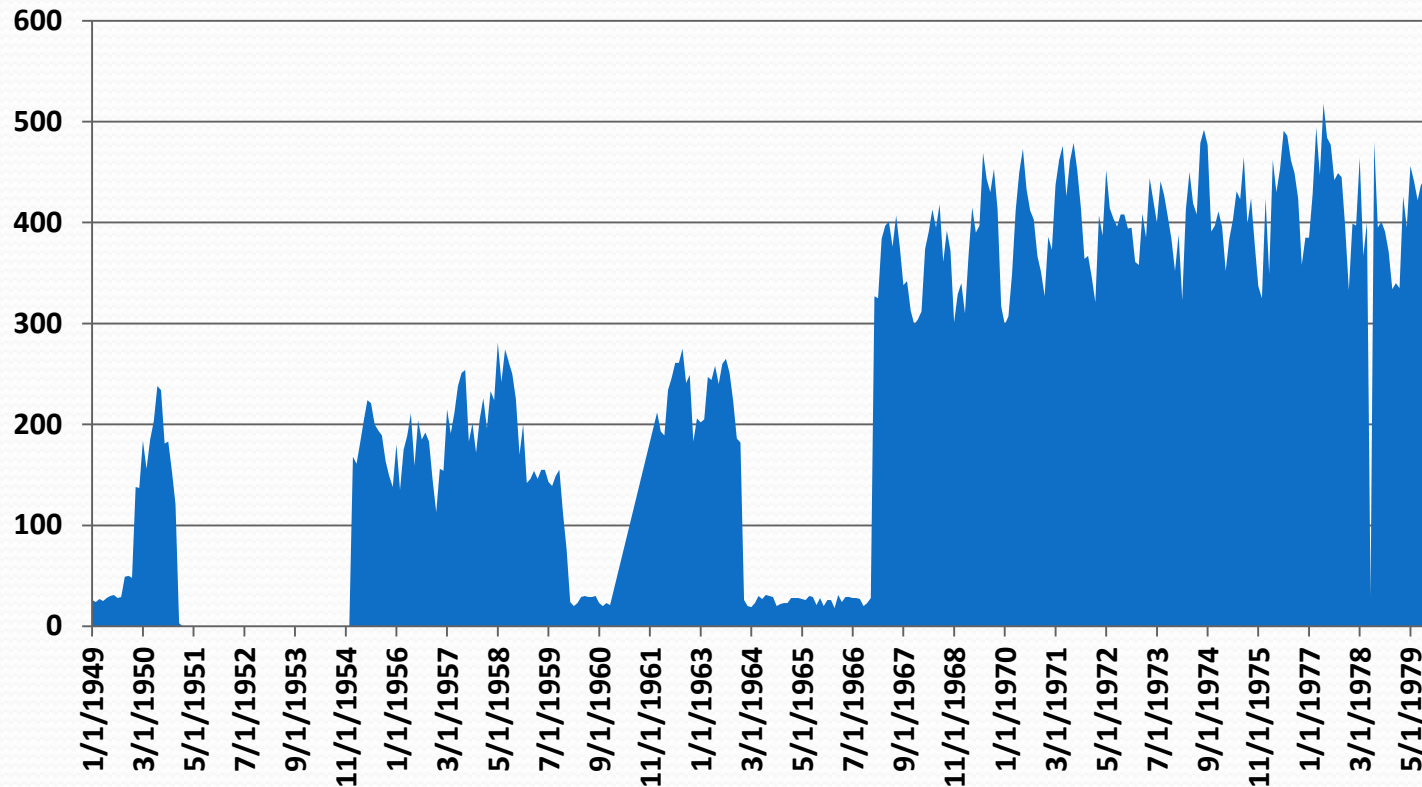
Number of observers in our database



No Zurich data!

Data for 1949-1979

Number of observations per month



Locarno since 1958, set of data fine since 1967


The Sunspot index computation

Rz to Ri in 1981

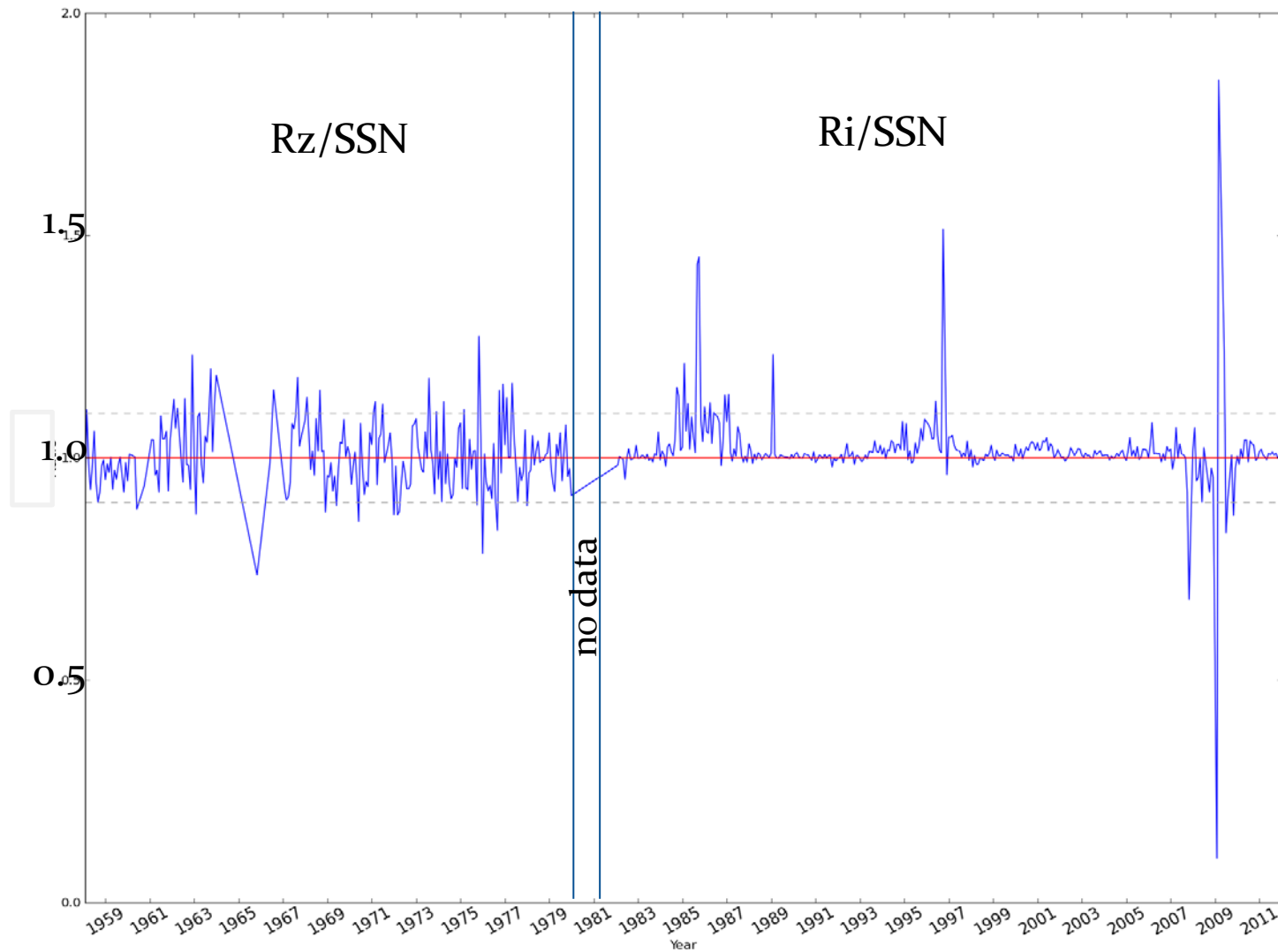
- Before 1981, Rz (Zurich)
- After 1981, Ri (SIDC network) is computed by a statistical method coded in FORTRAN described in [Clette & al].


[F. Clette & al] Advances in Space Research 40, Issue 7, 919--928 (2007).

- New PHP code using the same process as the fortran code, allows to flexibility experiment with variations such as:
 - Direct access to the database -> Possibility to **compute the SSN on the basis of old data.**
 - Partial set of observers
 - Change Pilot station
 - Change the range of dates for computation (fixed to one month in fortran code)
 - Exploration of other indices like **Group count [GC]** (spots=0) or **Sunspot count [SC]** (groups=0)

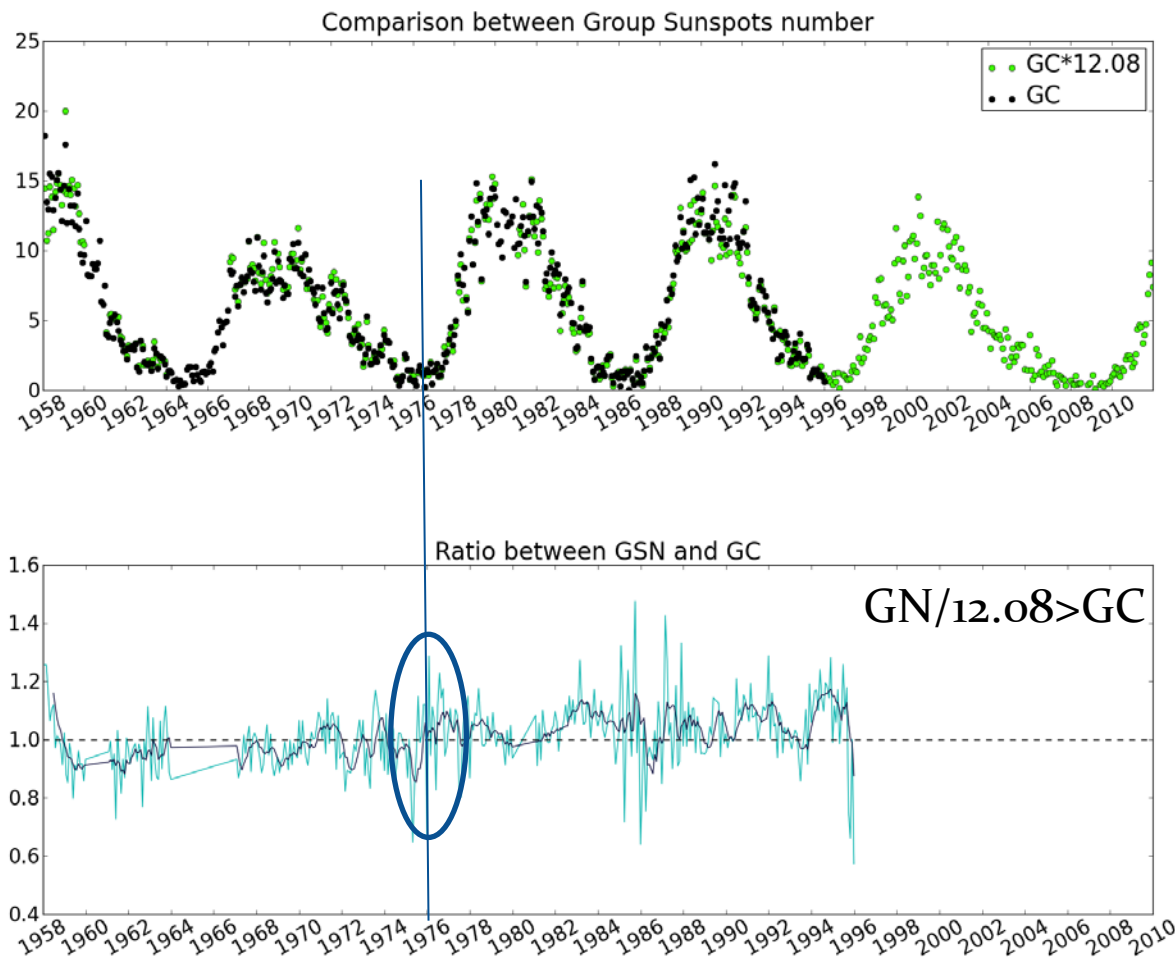
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- We applied the same new computation method(PHP) with the **same parameters** for the whole period where we have a data archive.
 - In FORTRAN, some threshold parameters changed over time.

Rz,Ri compared to SSN



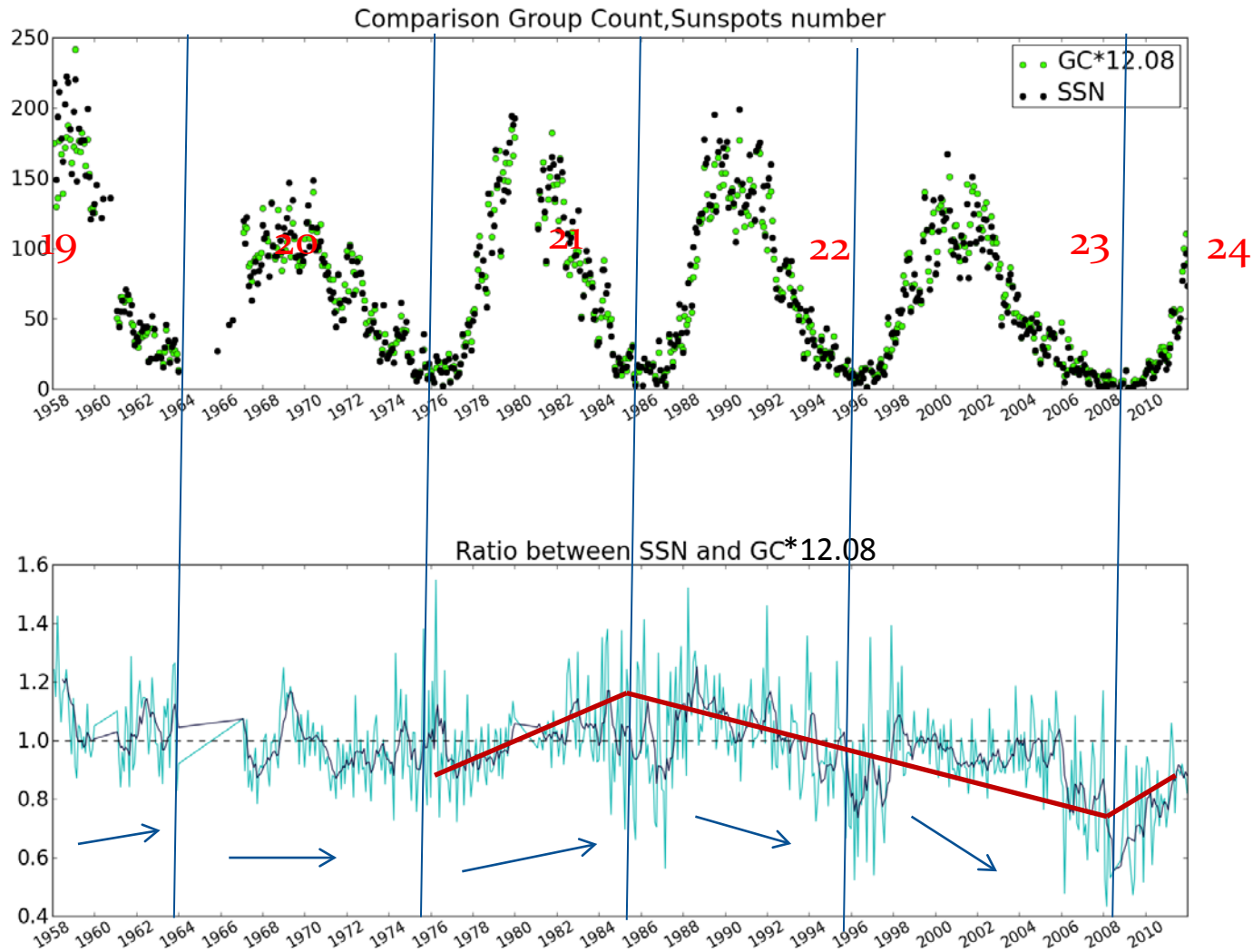
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- For the period 1958-1980, we conclude that the agreement between the new method and the fortran method is within 10%.
 - In the minimum periods, the discrepancy is higher due to rounded values at different points in the fortran method. But also due to ratio of small values.
 - We will focus now on **group count** and **sunspot count**.

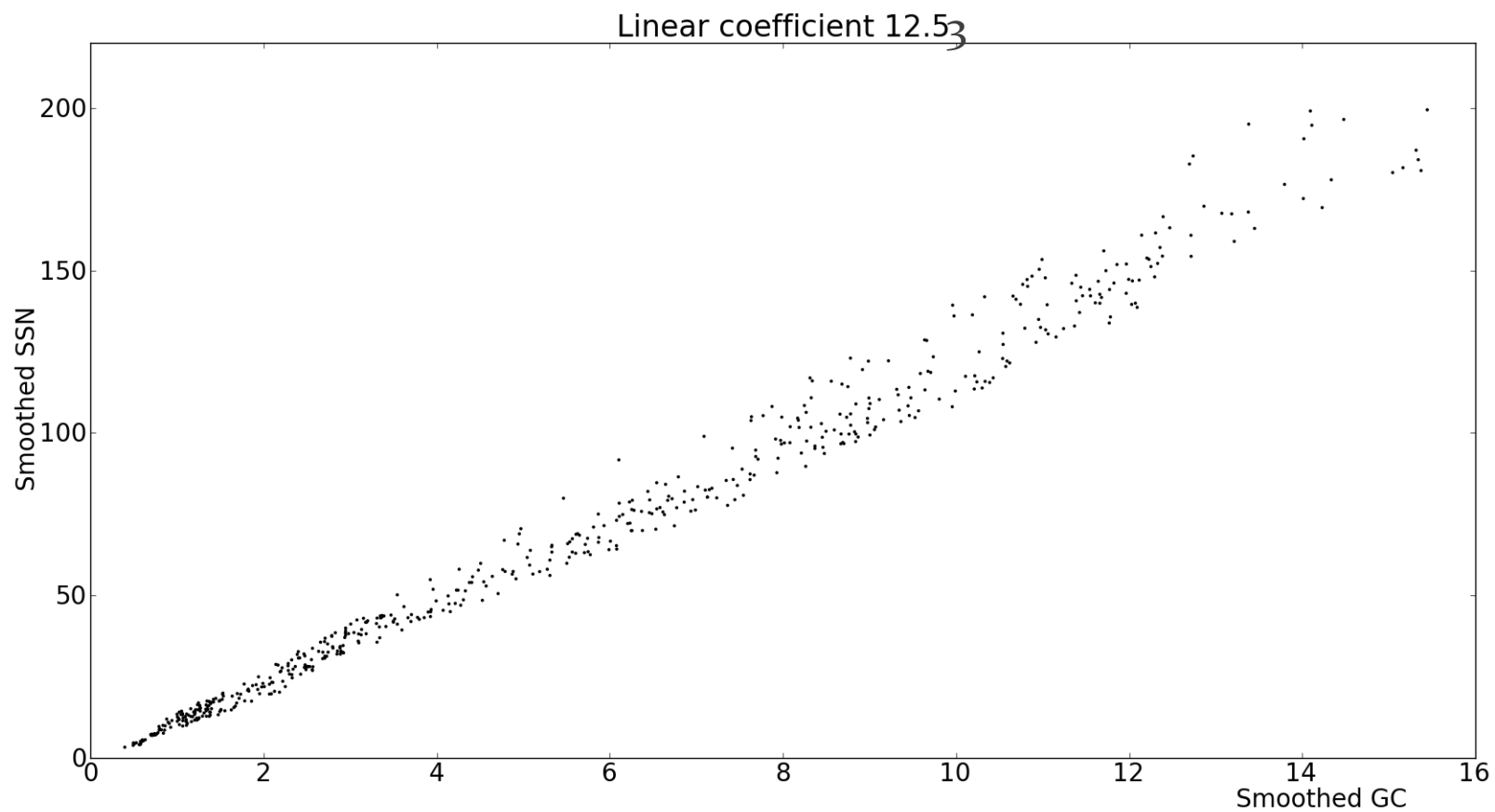
Group Sunspot Number computed by Hoyt and Schatten (GN) and by SIDC



Until 1976, GN has been computed with Greenwich data, after SOON drawing

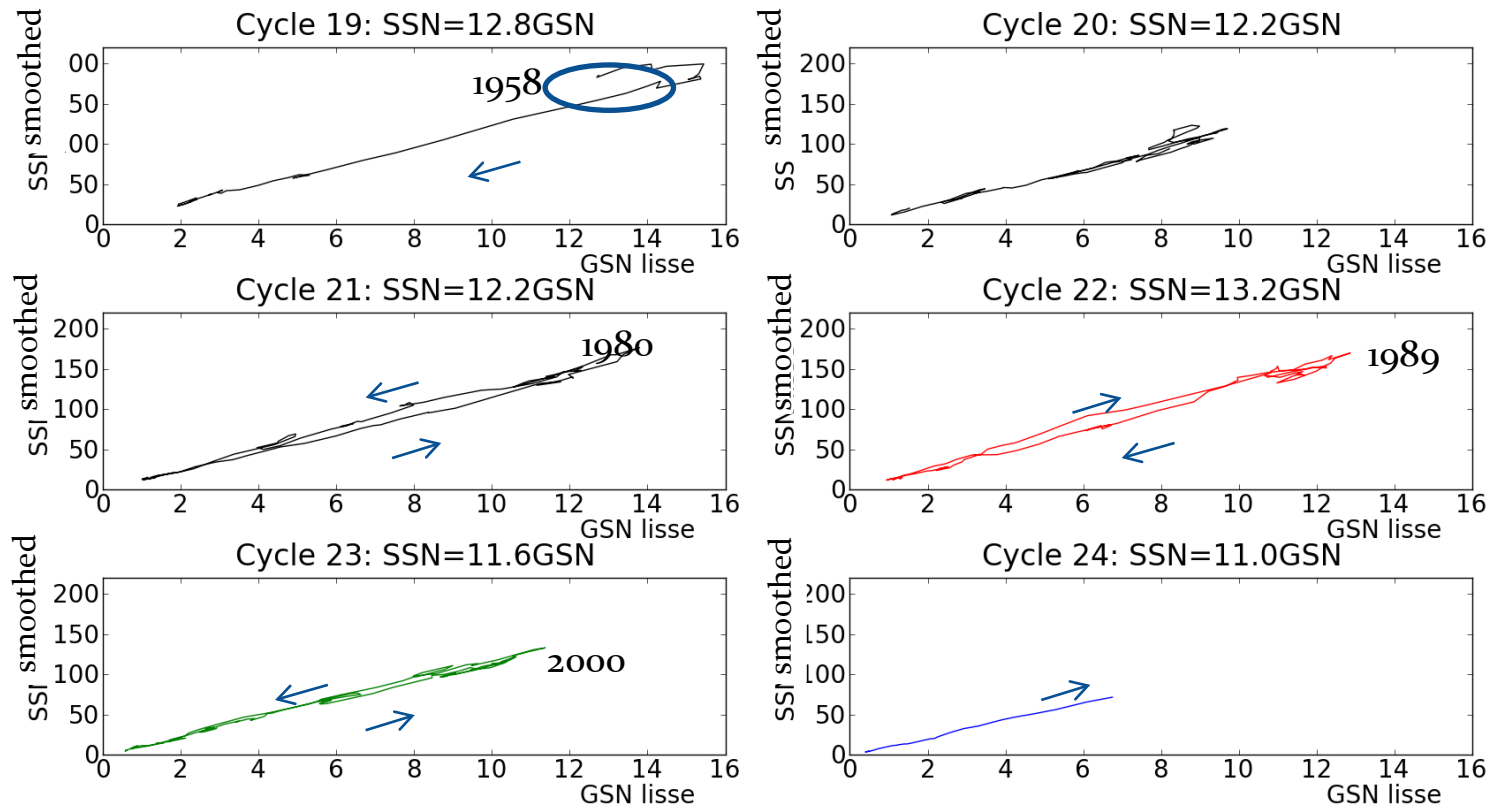
Comparison GC to Sunspot number (SSN)





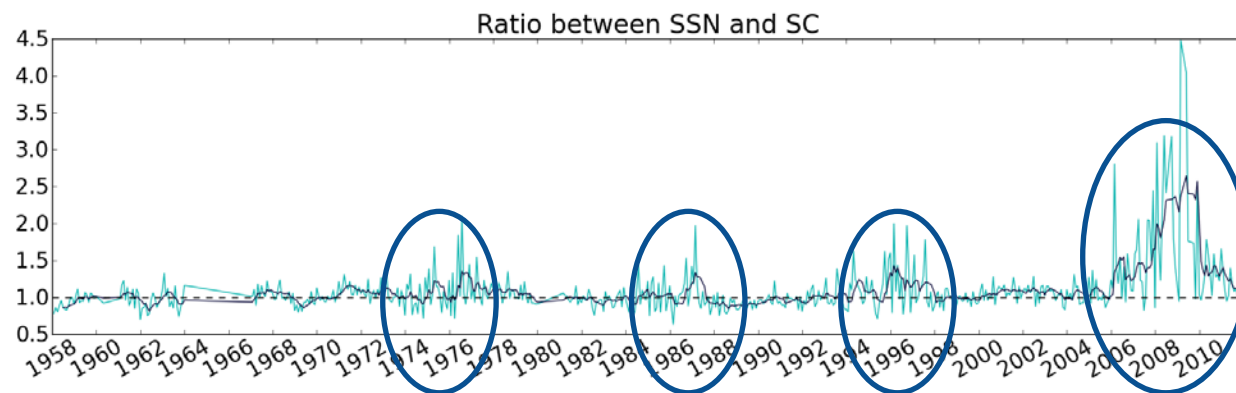
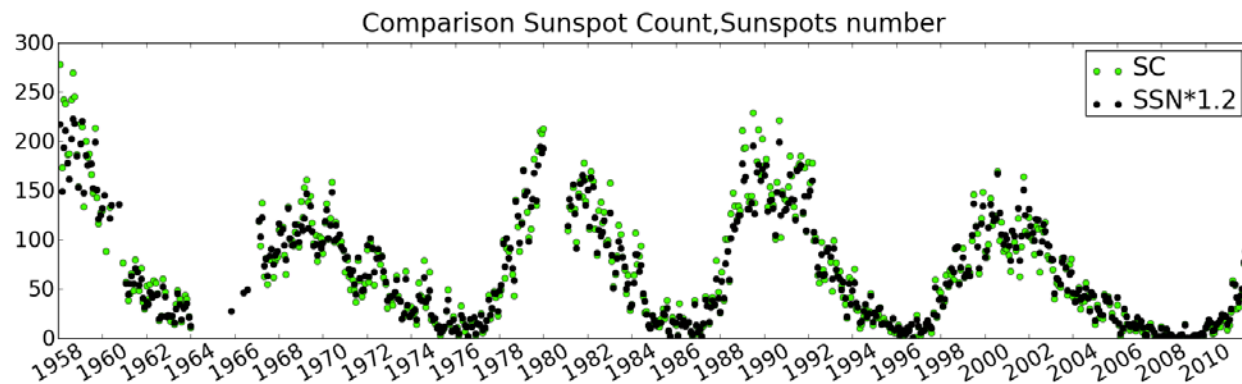
Smoothed on 6 months

Variation of SSN as function of GC



The number of sunspot per group decreases over the last two cycles.
Increase in the cycle 22.

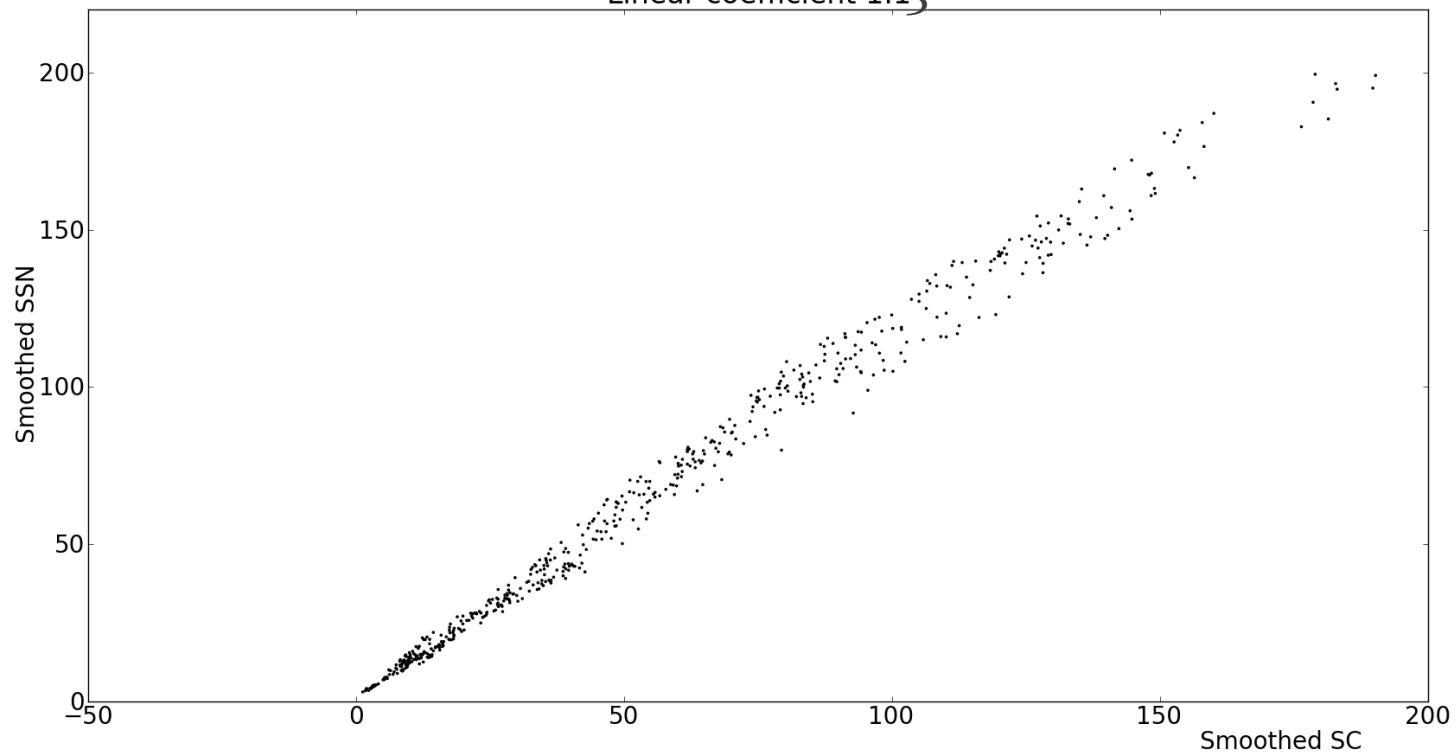
This coefficient of linear regression is linked to the maximum of SSN




SSN/SC → during minimum



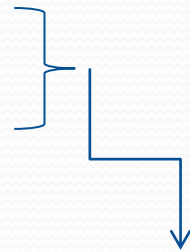
Linear coefficient 1.13





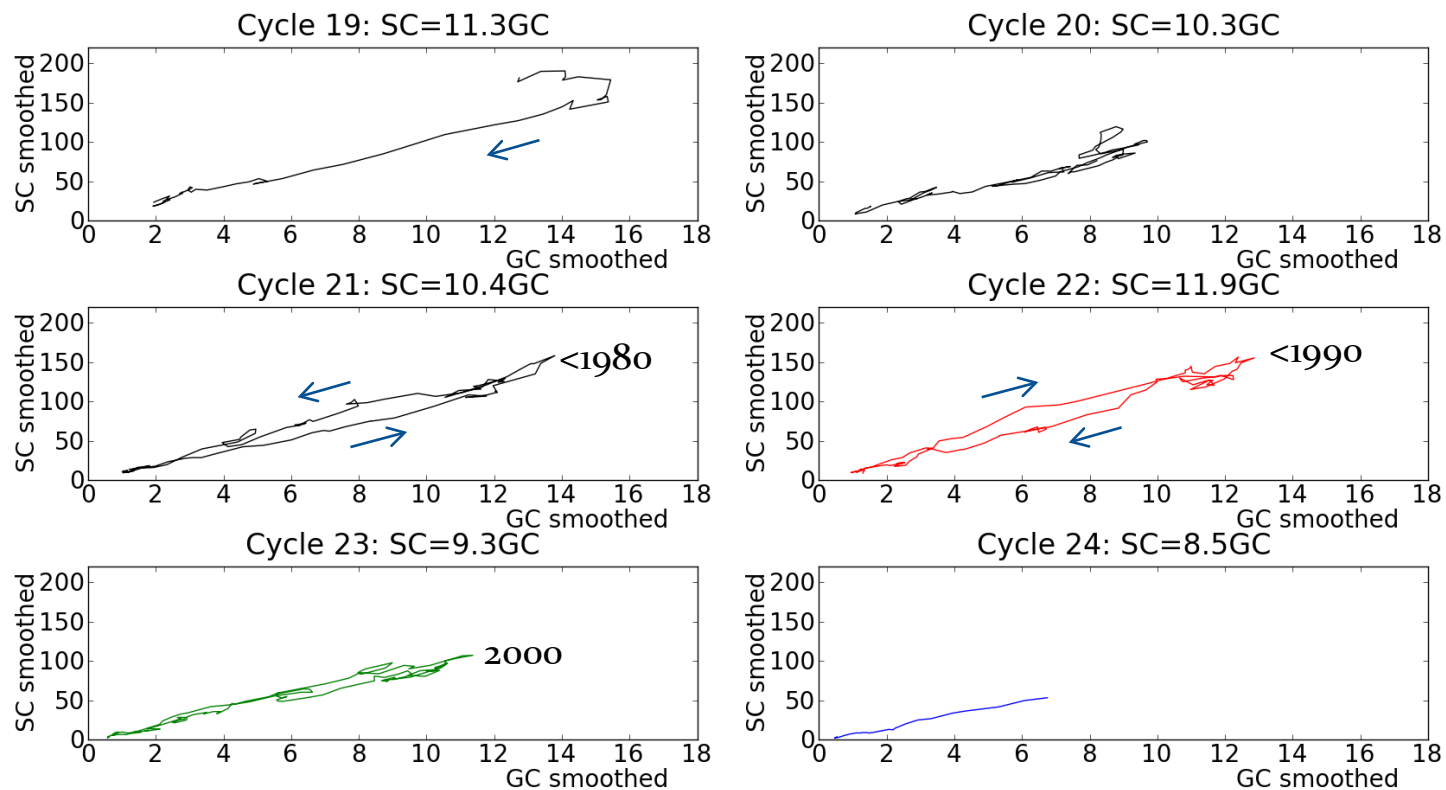
- $SSN=12.08$ GC

- $SSN=1.2$ SC



$SC=10.07GC \rightarrow$ tallies with $SSN=0.6(10GN+SC)$

SCount function of GCount

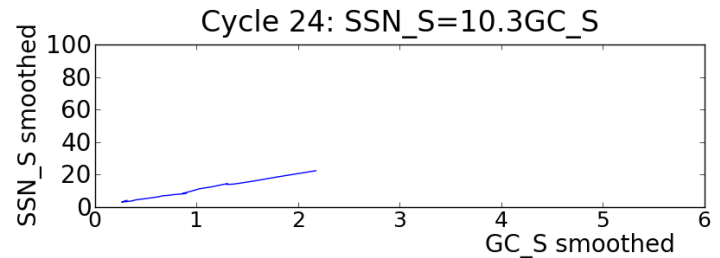
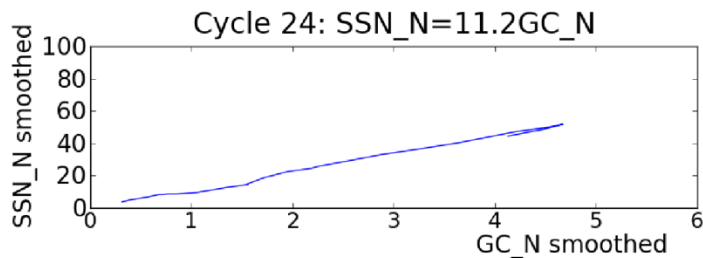
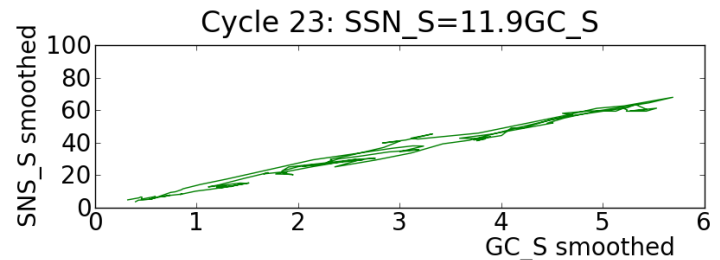
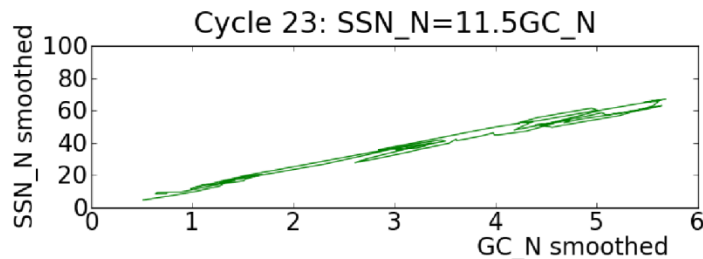
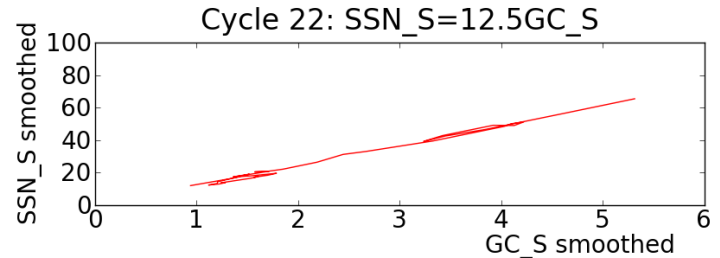
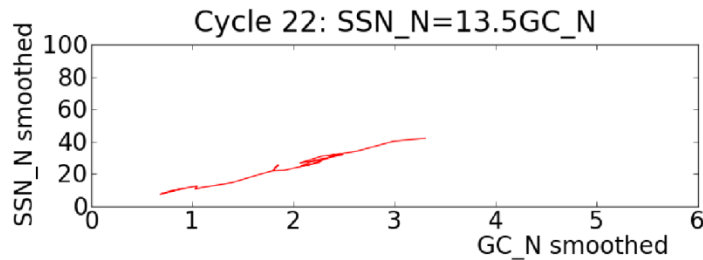


The sunspot count per group decrease over the two last cycles.

Conclusions

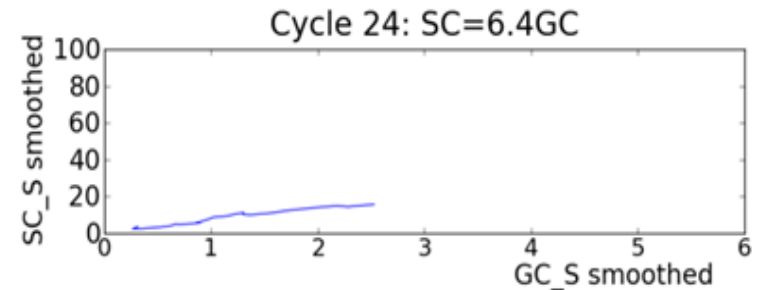
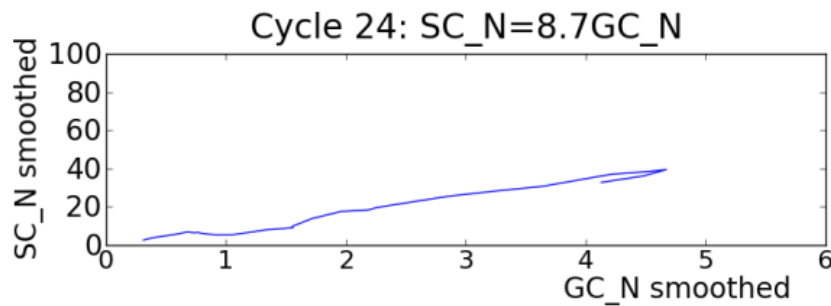
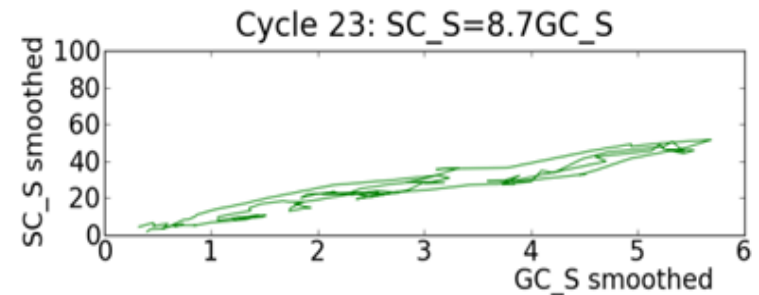
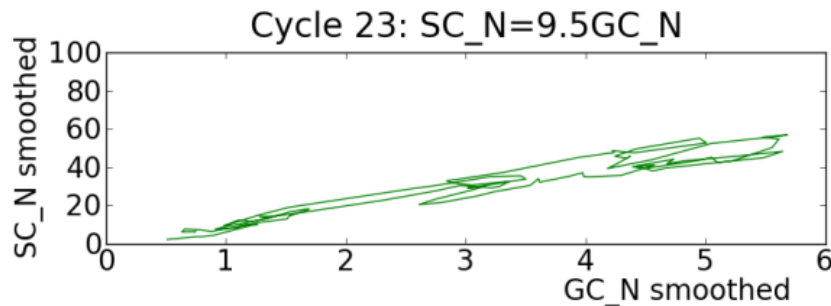
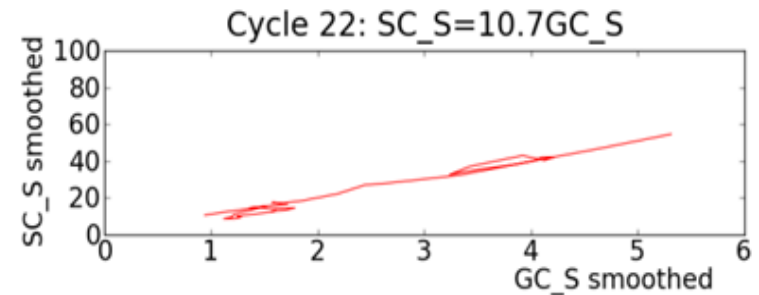
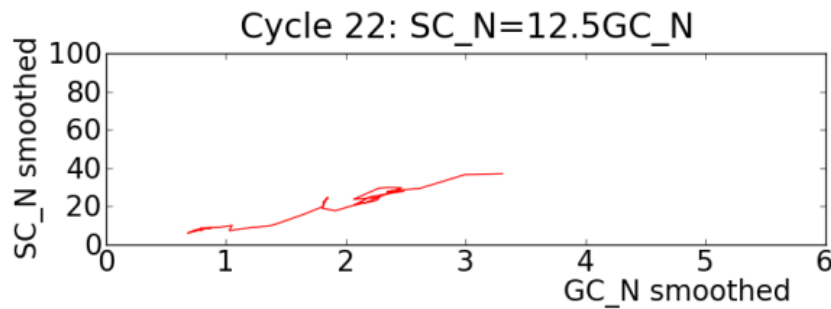
- We have a method to compute the sunspot index for any period where we have a data archive.
- The Group count computed with the same method over the period [1958,2011] shows the change of behaviour in Hoyt and Schatten Group Sunspot Number in 1976.
- The ratio $SSN/GC \times 12.08$ has the Z behaviour like in Frédéric's presentation.
- The sunspot index(SSN) per group decreases over the last two cycles.
- The sunspot count(SC) per group decreases over the last two cycles.
- The sunspot index(SSN) and the sunspot count per group increases for the cycle 22
- $G_{max} \times coef_lin = \max SSN$
- The coefficient doesn't change for the increasing part of the given cycle.
- Cycle 24, max Group: 16 -> $\max SSN = 11 \times 16 = 171$
If max Group: 12 -> $\max SSN = 132$

Variation of SSN_N as function of GSN_N

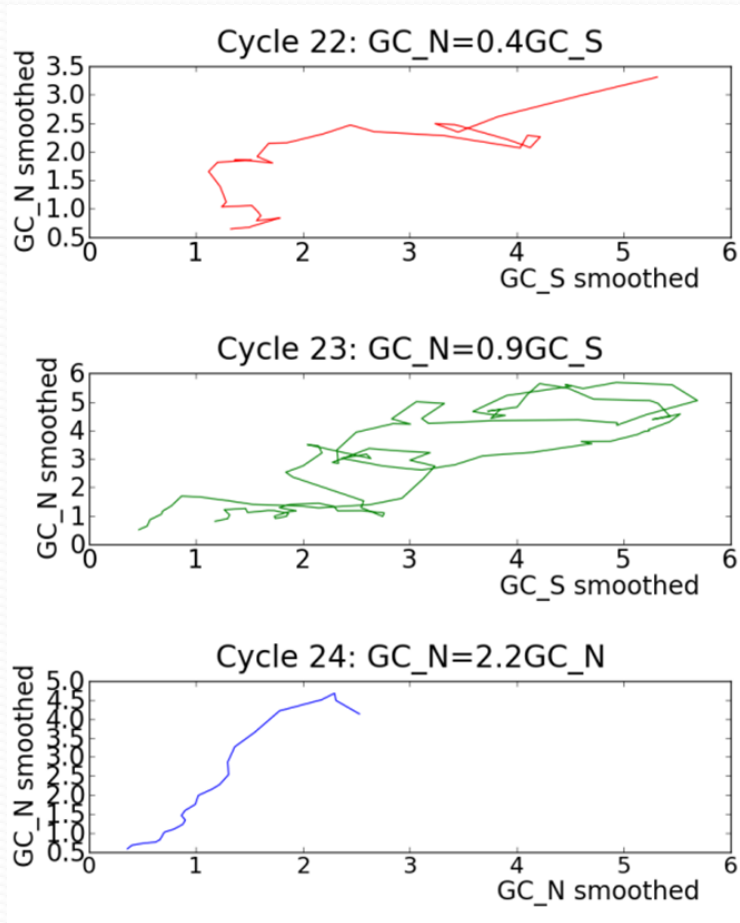


For the cycle 23, the results are similar for the two hemisphere.
Same coefficient for north than for total sun for the complete cycle 23.
Coefficient for North are ~coefficient for total one.

Variation of SC_N as function of GC_N



GC north as function of GC south



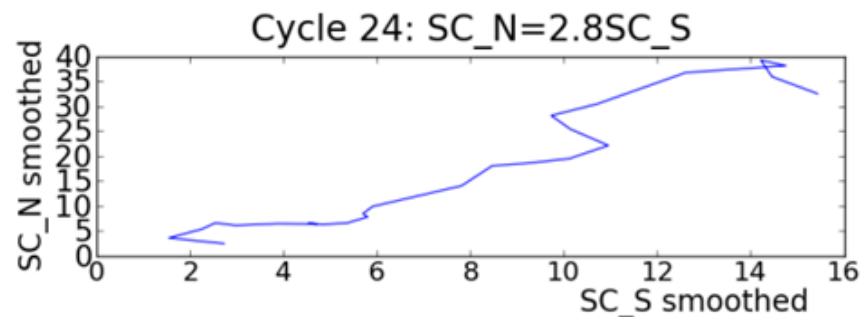
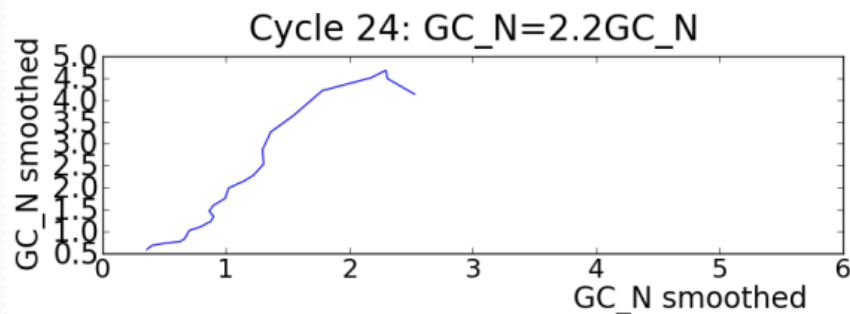
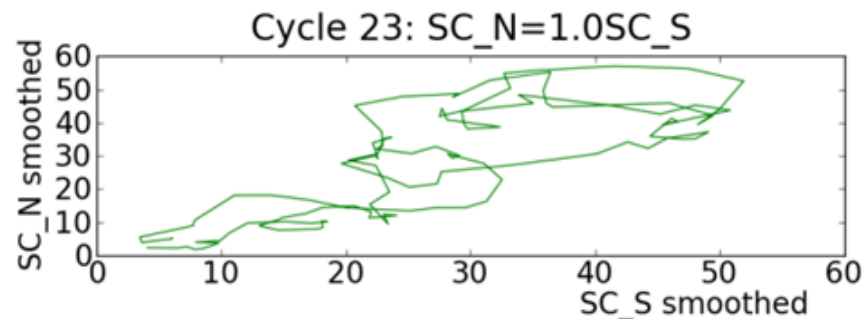
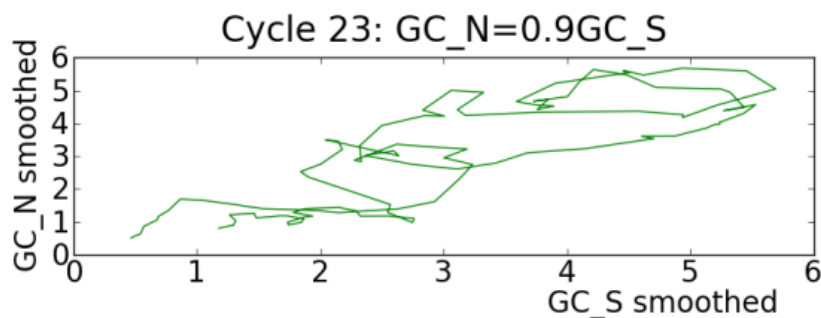
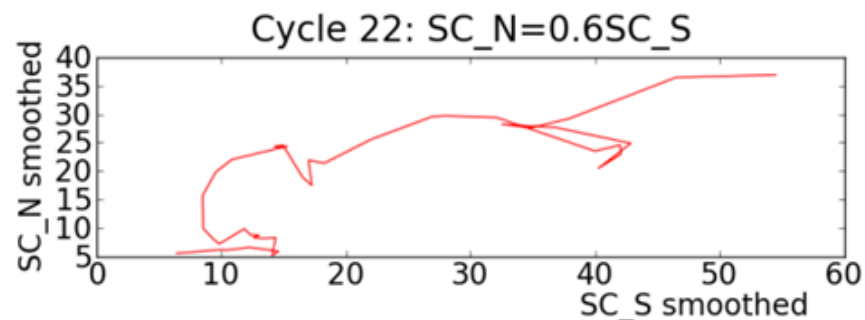
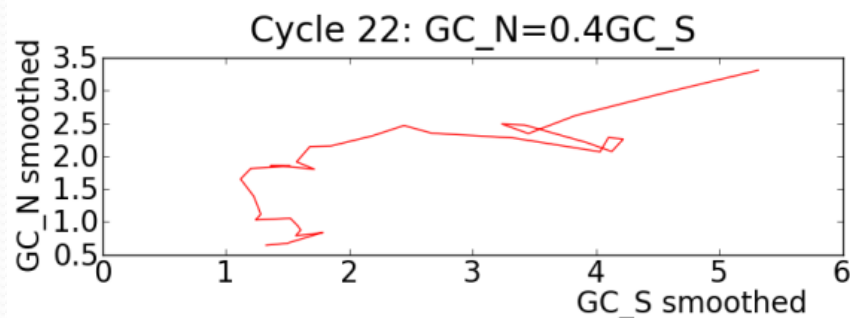
$GC_N \sim 1/2 GC_S$

$GC_N \sim GC_S$

$GC_N \sim 2 GC_S$

Asymmetry North-south

GC/SC north as function of GC/SC south



Groups Count

Sunspots Count



The end