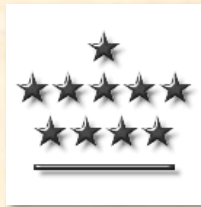


Reconstructions of the group sunspot number 1981 - 2012

Frédéric Clette & Laurence Wauters



SIDC – WDS “Sunspot Index”
Royal Observatory of Belgium



A new framework for the R_i calculation

- Since 2005, new Web interface for data input:
 - On-the-fly data consistency control (PHP)
 - Direct input to the global database
- Global database of all SIDC data:
 - Reported group and sunspot counts for each station
 - Total and hemispheric numbers
 - All data since the creation of SIDC (1981-2012 = 31 years)
- SSN calculation algorithm converted from FORTRAN to PHP:
 - Direct access to the database
- New possibilities: **full re-computation of the sunspot number**:
 - Change of pilot station (or no pilot station)
 - Computation based on a user-defined subset of the entire SIDC network
 - Exploration of other computing methods or other indices:



e.g. group number

WOLF Interface

Formatted file for Area: Totals MONTH: 07 YEAR: 2006 STATION: ALL Station

Search Station by: Any string LIKE: Locarno

Sunspots Collection Products Change STATION Definitions Rules

SUNSPOTS COLLECTION for your UCCLE BELGIUM STATION

Please fill the form to include your data, click on SEND to submit it Help

All days of the month All days of the July month MONTH: YEAR: Other month

Click column to have a tab order per column or click line to return to an insertion data per day (the default)

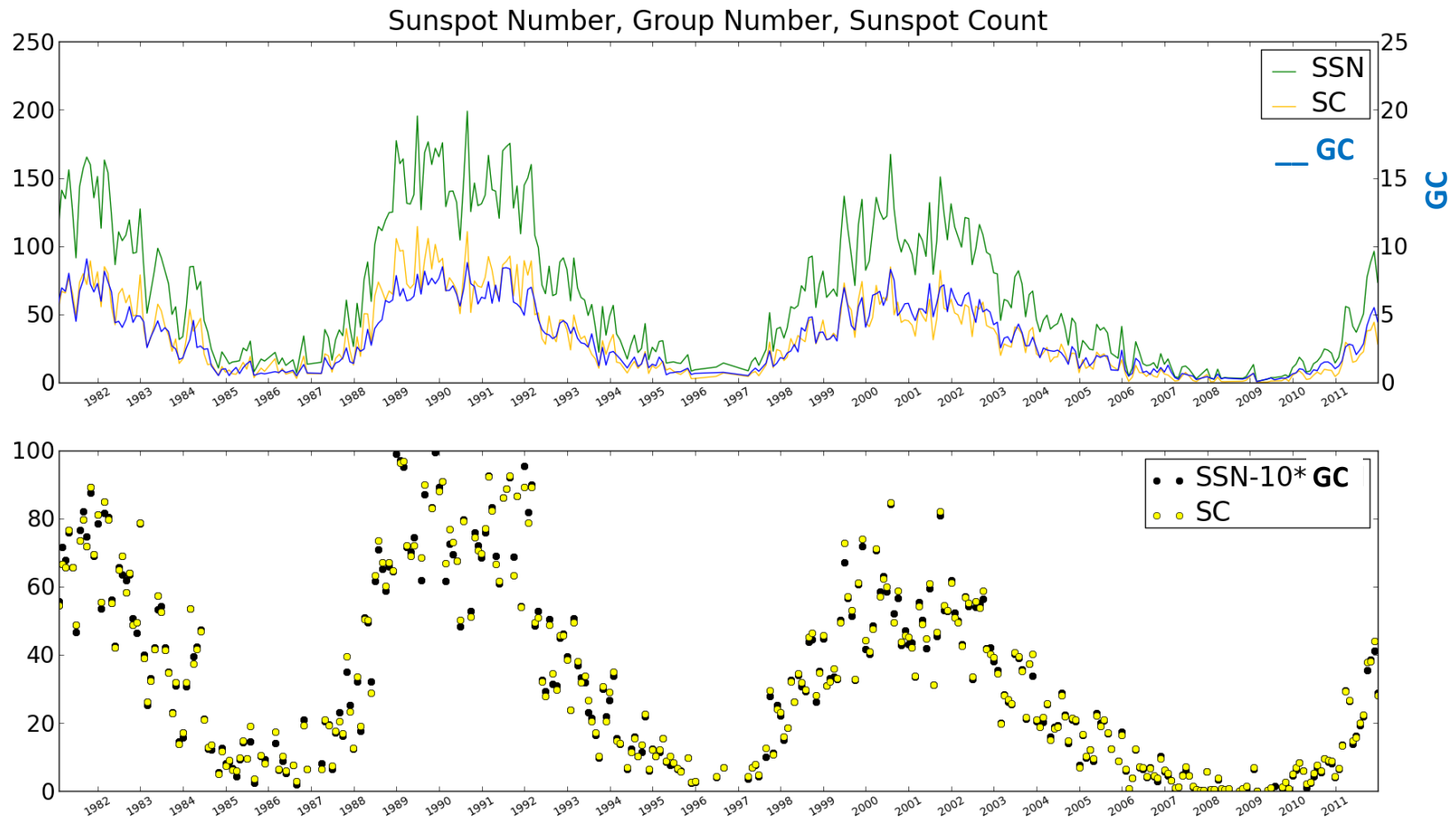
No value=empty field 0=the value is really 0 Totals fields(*) are required when you put something for a given day

Month	08	Year	2006	Total	North	South	Center							
Day	Time	Quality	Groups	Sunspots	Wolf	Groups	Sunspots	Wolf	Groups	Sunspots	Wolf	Groups	Sunspots	Wolf
01	1500	3	1	5	15									
02	1030	2	1	1	11									
03	0845	3	2	2	22									
04	1445	3	0	0	0	0	0	0	0	0	0	0	0	0
05	0945	3	1	1	11									
06	1045	3	0	0	0	0	0	0	0	0	0	0	0	0
07	0845	3	0	0	0	0	0	0	0	0	0	0	0	0
08	0820	3	1	1	11									
09														
10	1530	3	3	12	42									



Separating group and spot counts

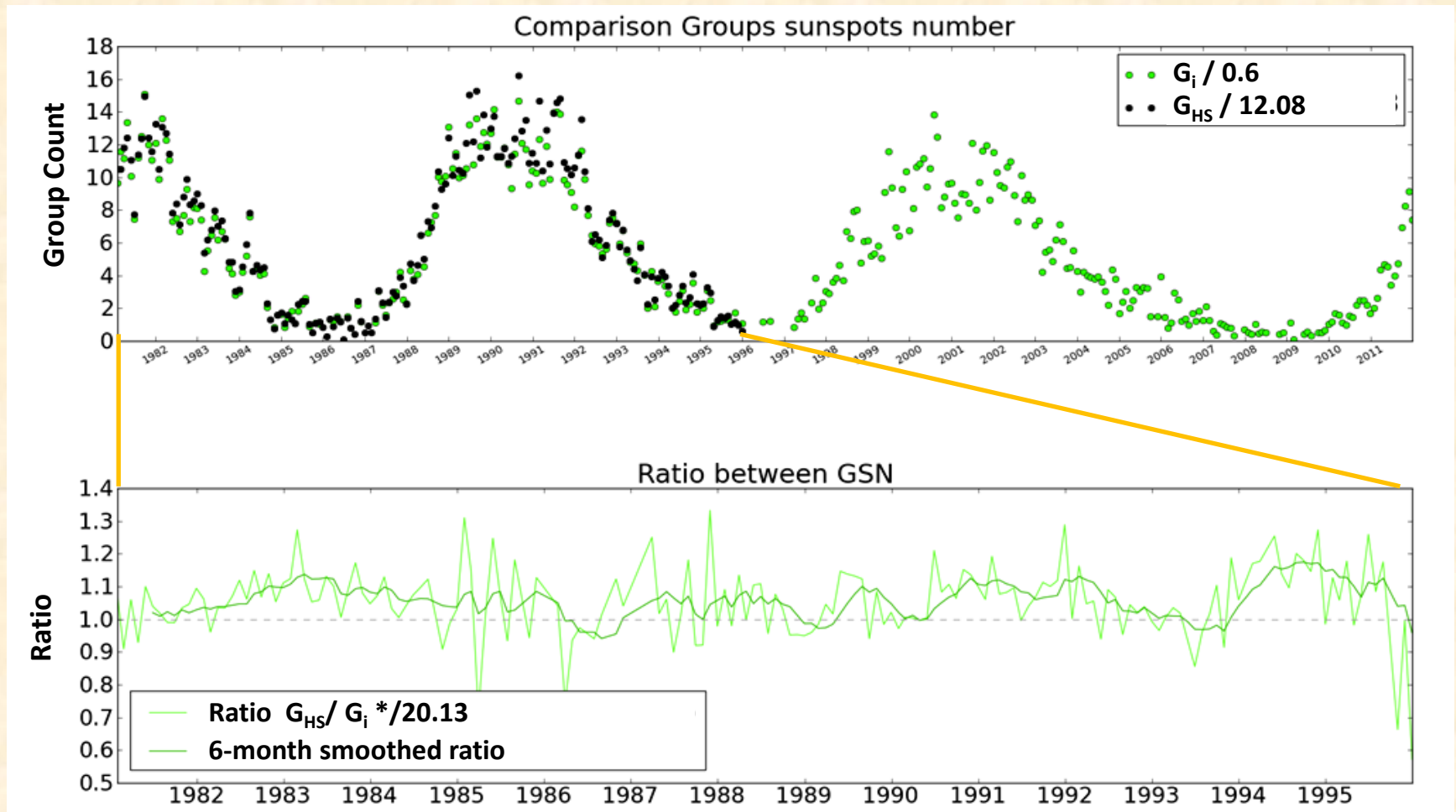
- GC= group count, SC= spot count, SSN= $10*GC+SC$
- Validation test (Pilot station: Locarno)





Original GSN versus its SIDC reconstruction

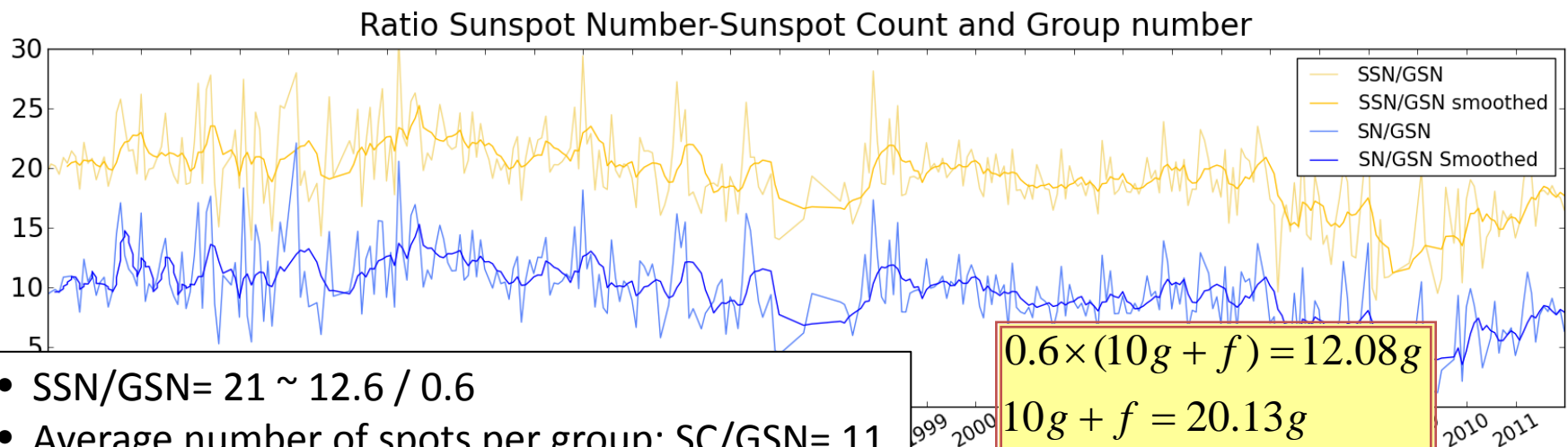
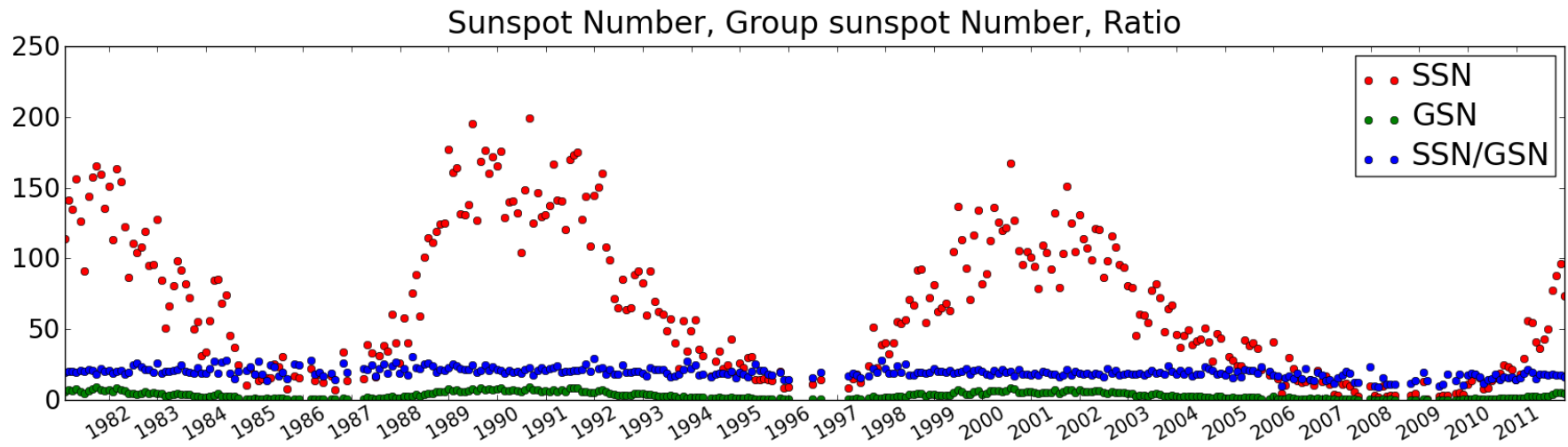
- SIDC pilot station: Locarno (raw group count * 0.6)



- Good agreement: ratio close to 1: $G_{HS} = 1.05 G_i$ over 1981 - 1997



Ratio Group count / spot count (*Locarno*)



- $SSN/GSN = 21 \sim 12.6 / 0.6$
- Average number of spots per group: $SC/GSN = 11$
- Decreasing trend in cycle 23

$$0.6 \times (10g + f) = 12.08g$$

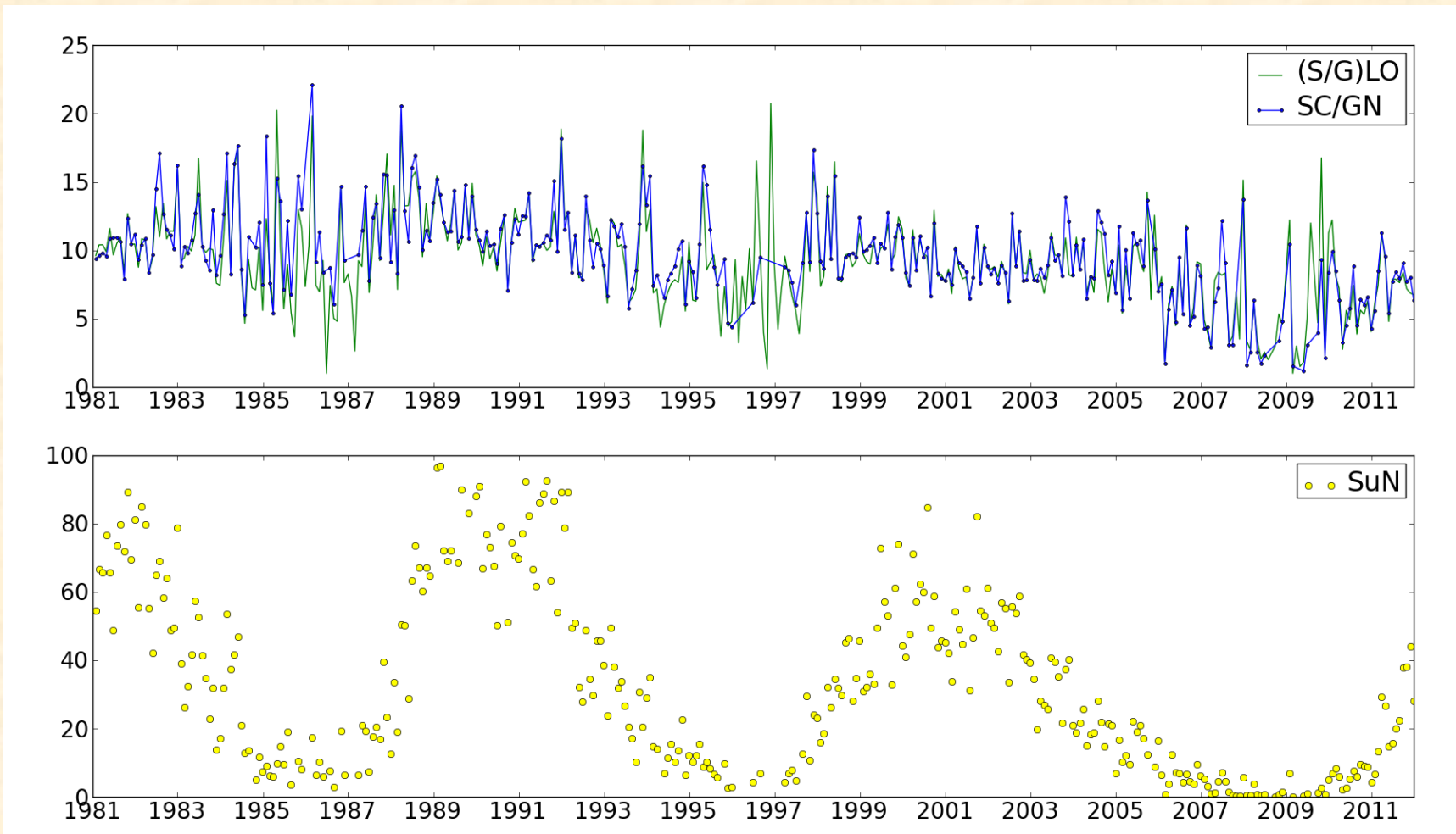
$$10g + f = 20.13g$$

$$f = 10.13g$$



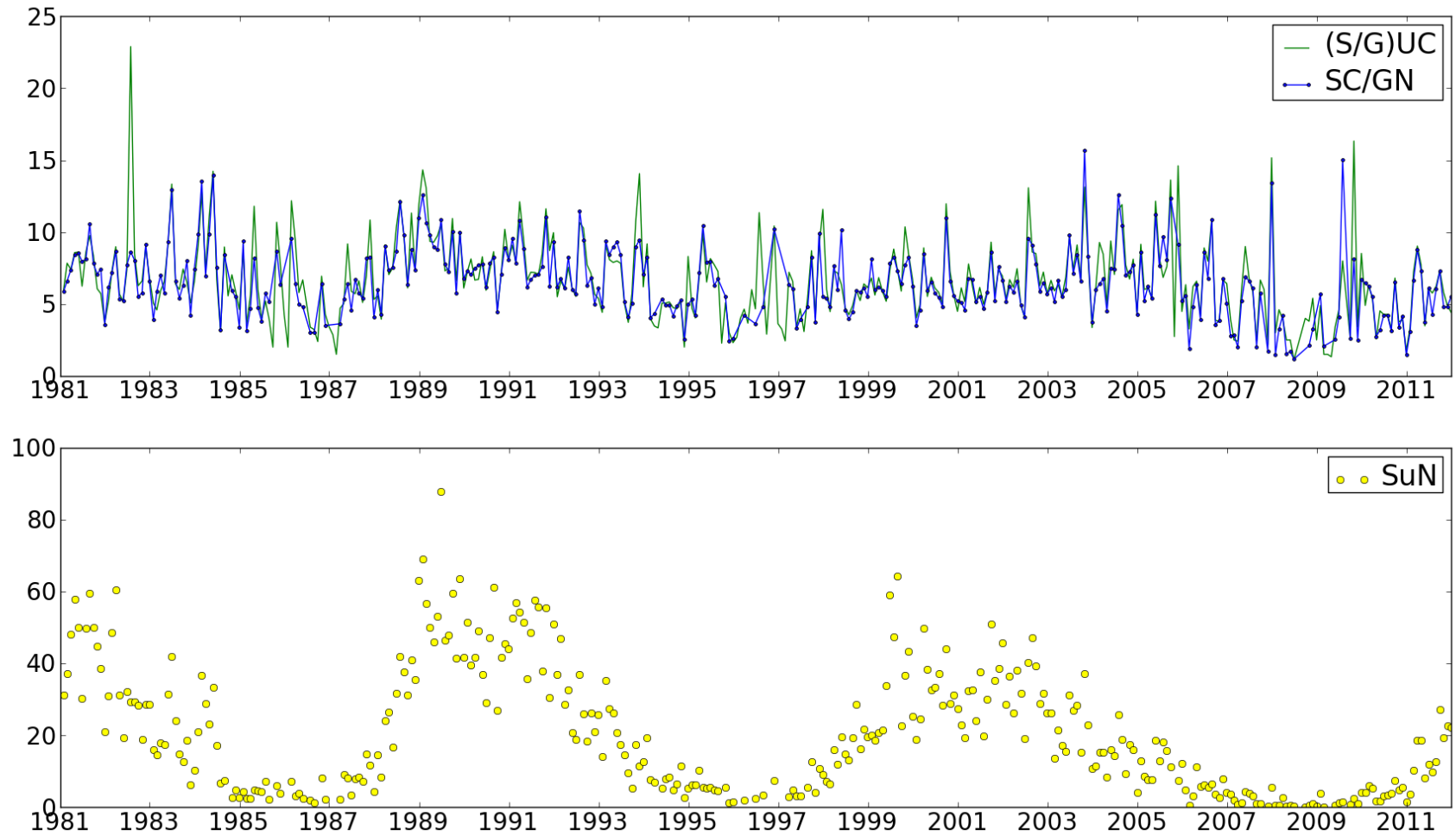
SC/GC ratio: Station Locarno vs network index

- Network index: reduced dispersion compared to station alone.





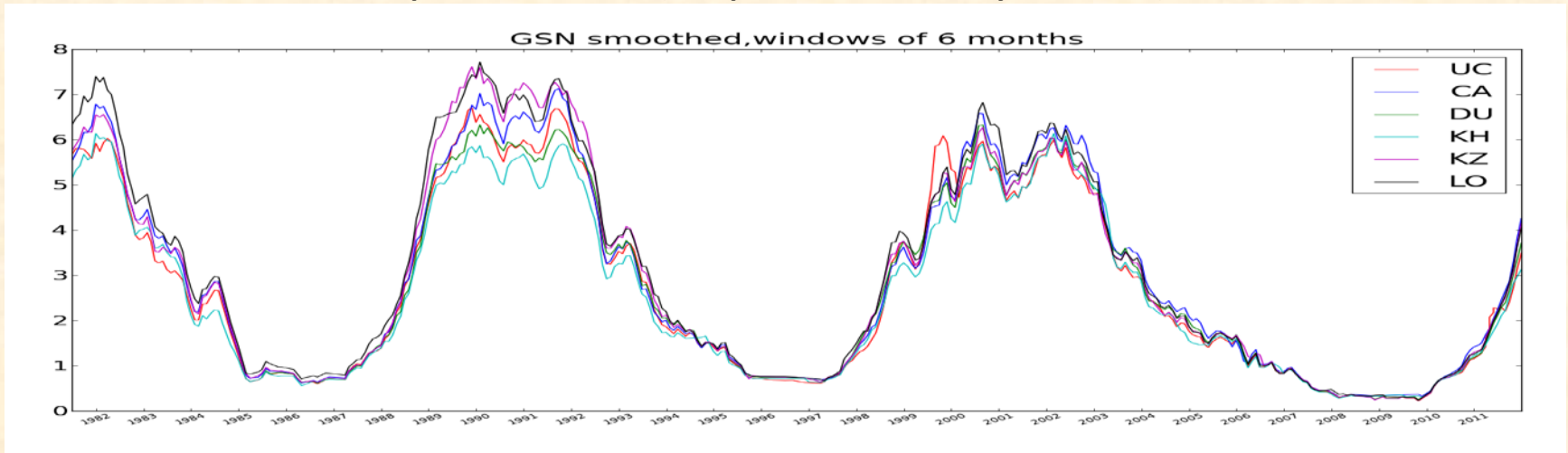
SC/GC ratio: Station Uccle vs network index



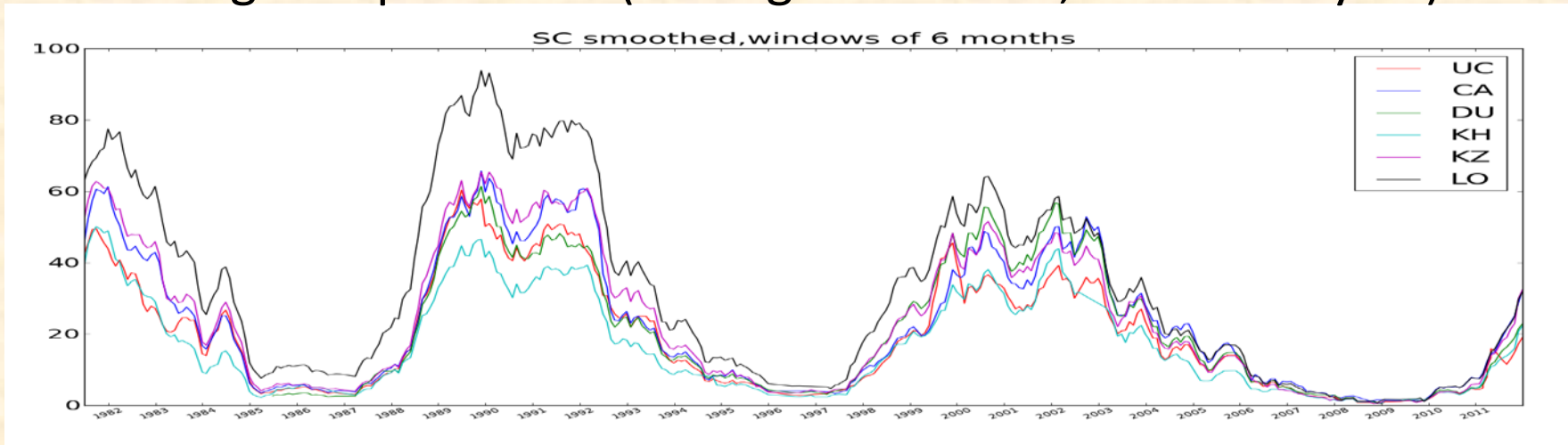


Dependance on the pilot station

- GC: limited dependance (in particular cycle 23)

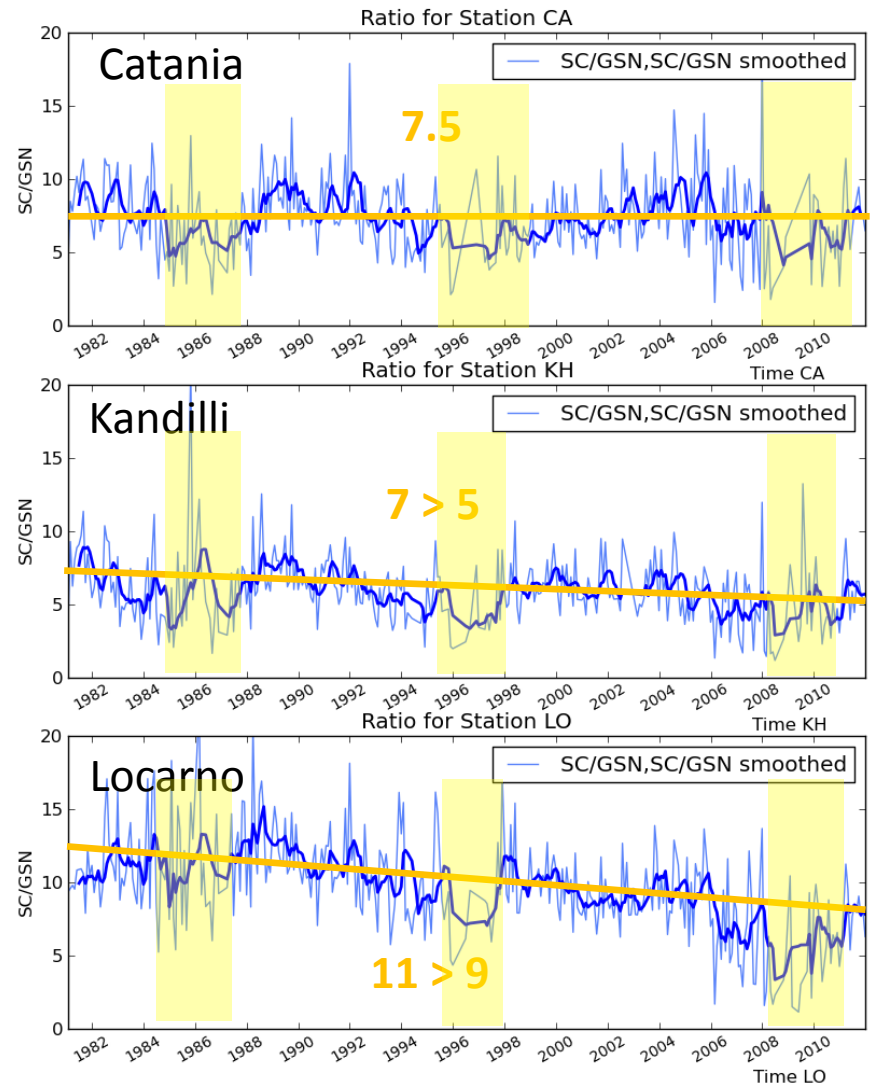
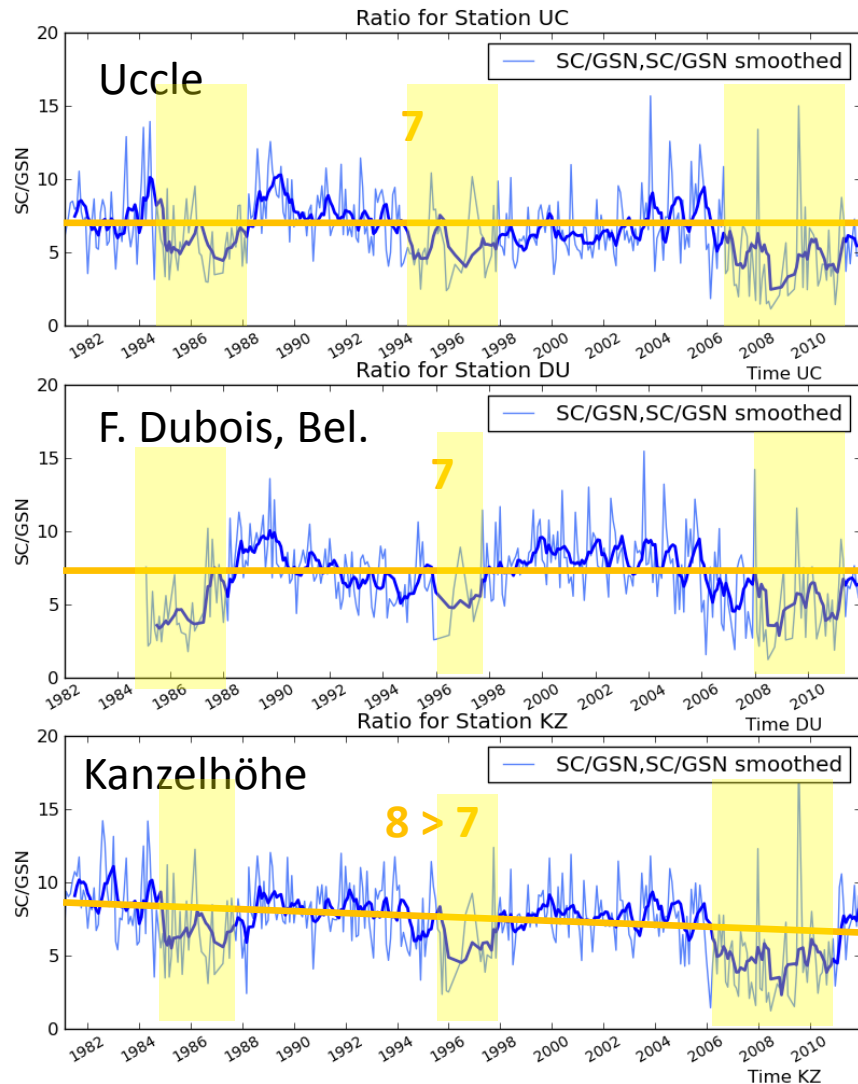


- SC: larger dependance (LO: highest counts, followed by KZ)



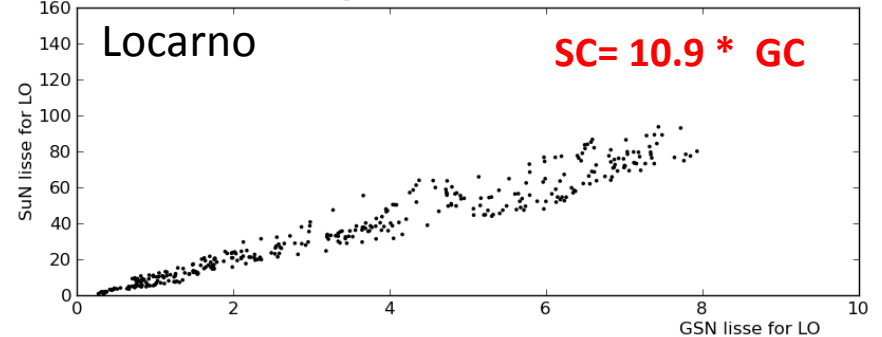
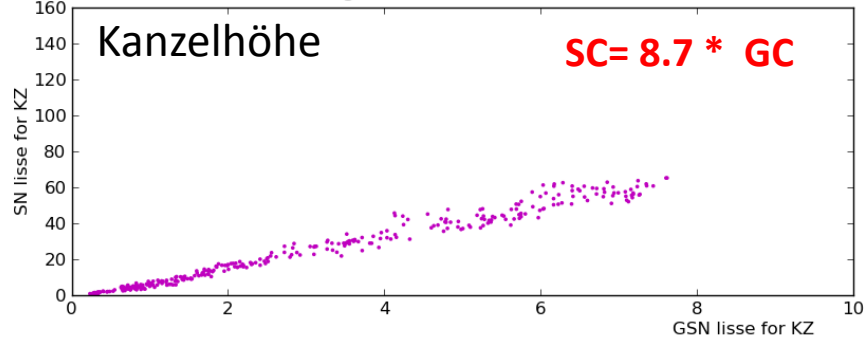
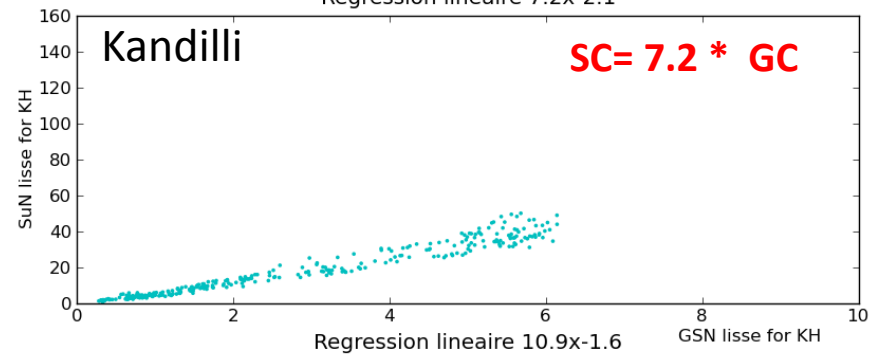
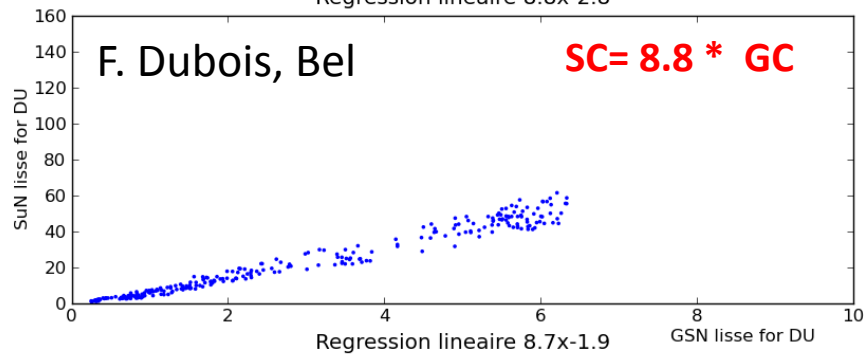
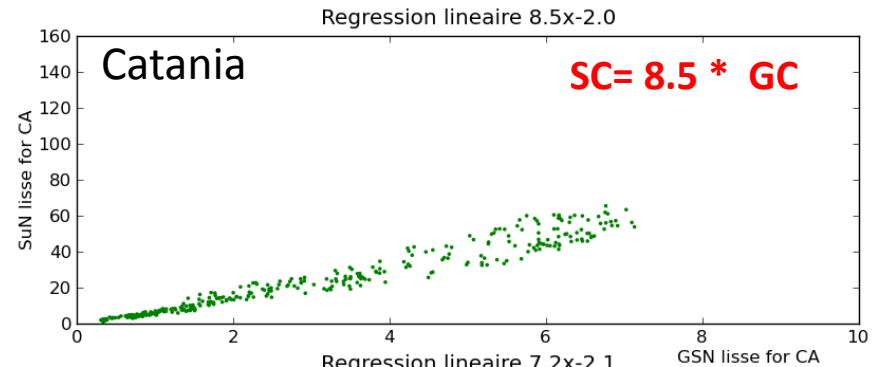
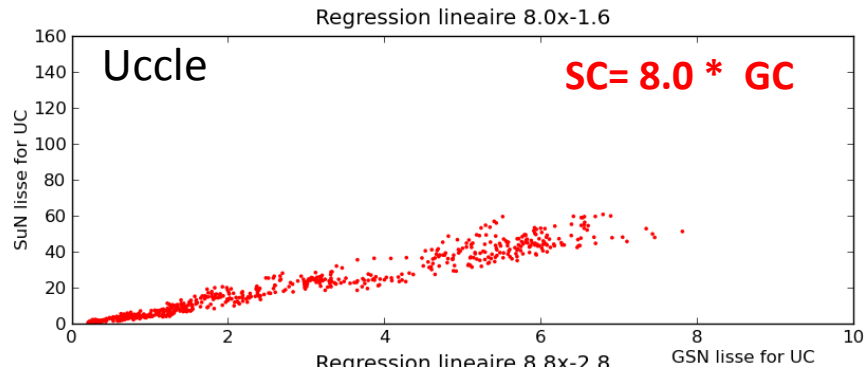


SC/GSN for different stations



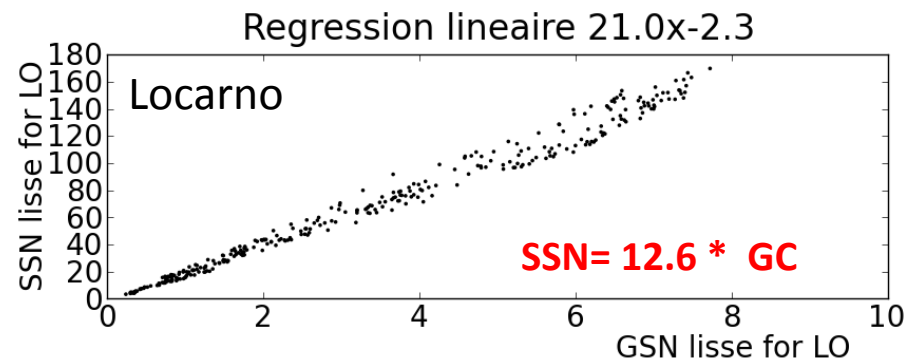
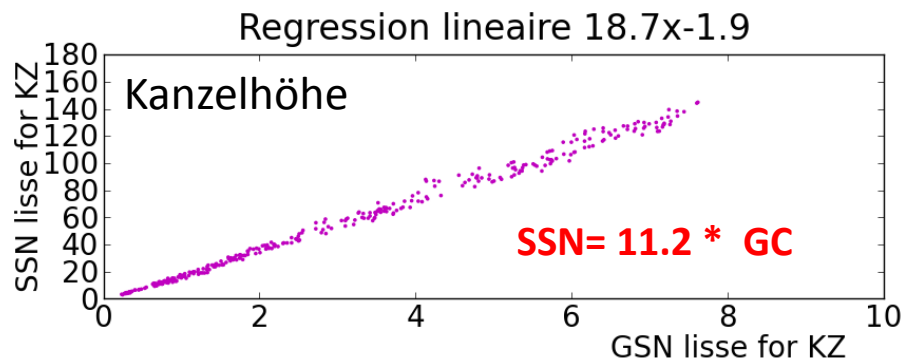
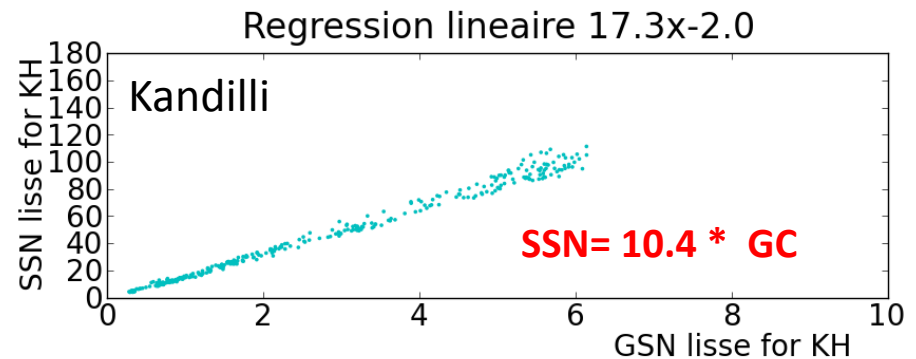
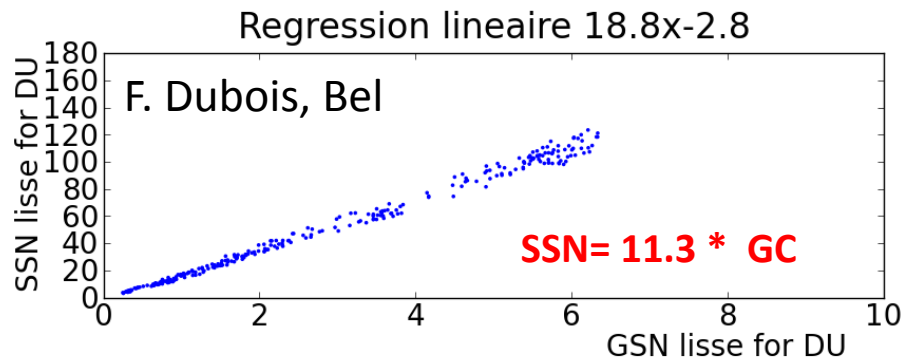
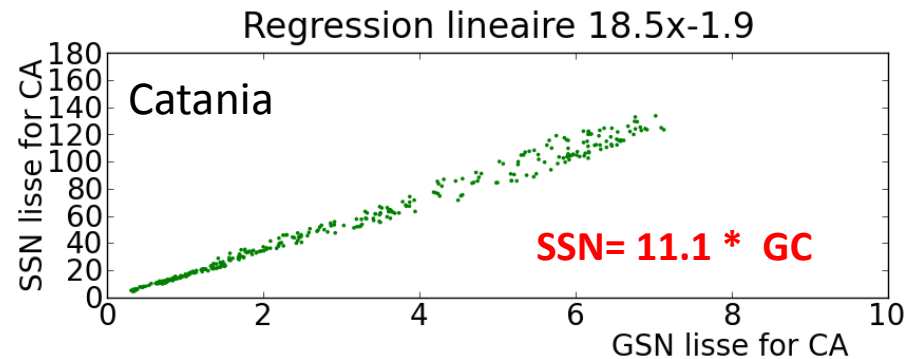
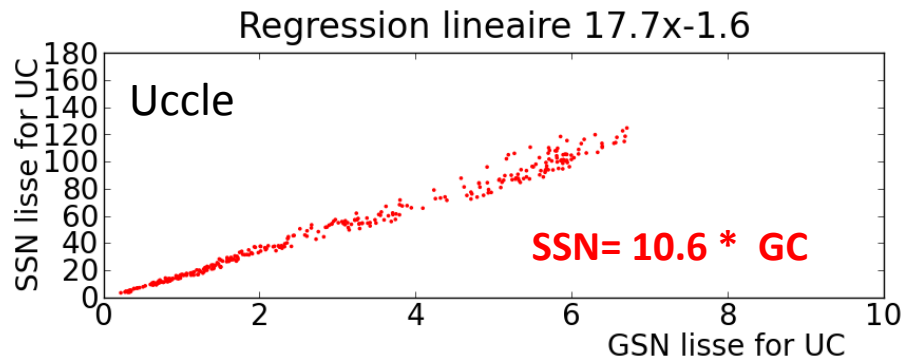


SC/GC for different stations





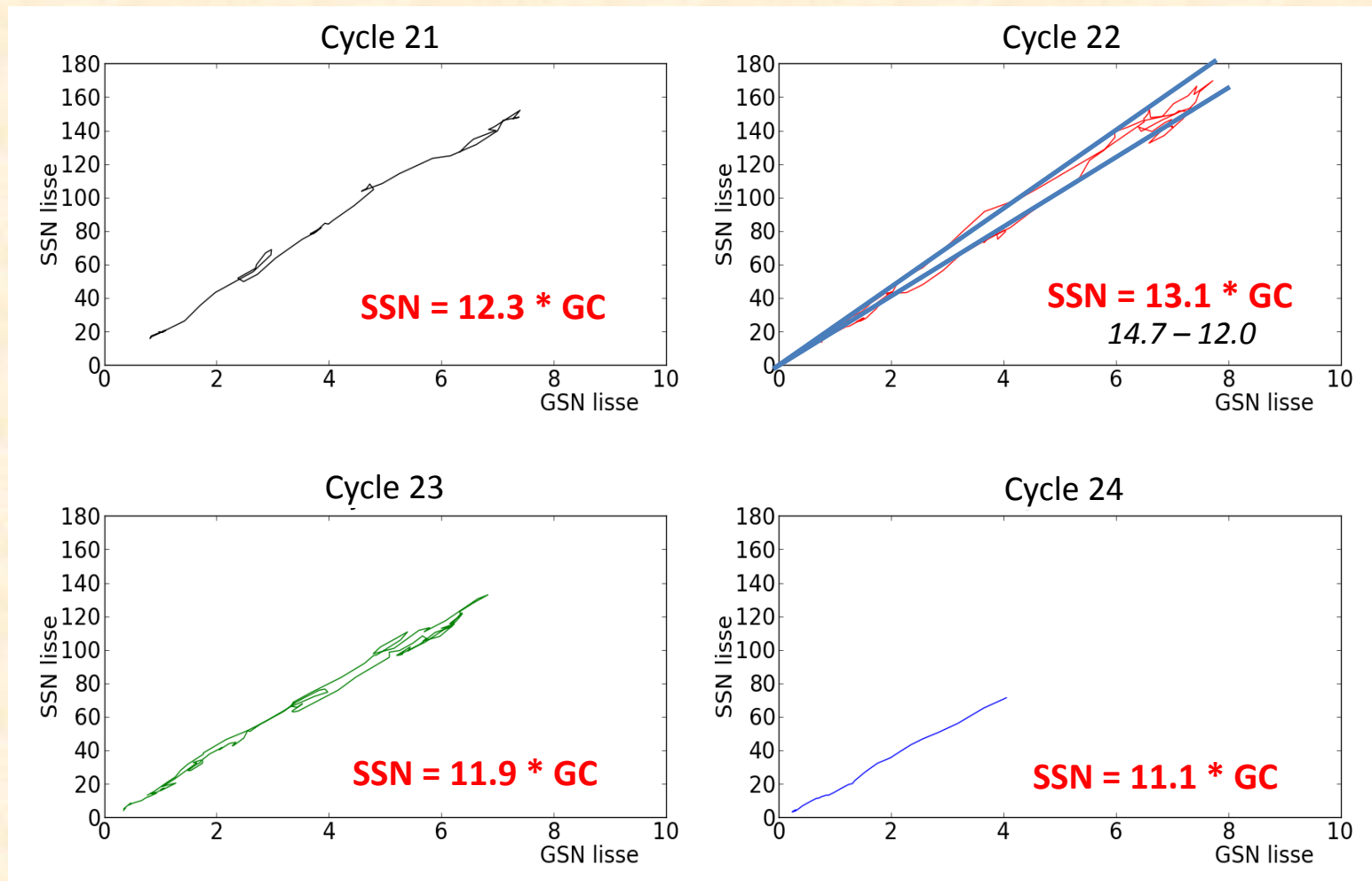
SSN/GC for various stations





SC versus GC over 3 cycles (*Locarno*)

- Ascending and descending phases do not overlap for cycle 22 (loop)





Conclusions

- **SIDC database: brand new tool to:**
 - Validate past calculations
 - Explore the influence of different parameters:
 - observer quality & location
 - temporal bin size
 - thresholds used in statistical data filters
 - Explore different sunspot indices (versus the canonical Wolf formula)
- **Group sunspot number:**
 - Overlap period 1981 – 1997: good scaling agreement with the reference group SSN (*Hoyt & Schatten 1998*)
 - **Solar cycle variation in the ratio SSN/GSN:**
 - Flat ratio during most of the cycle
 - **30% reduction during minima:** small A, B, C groups dominate
 - **Deviation/trend in the ratio (cycle 23) only for a few stations, including Locarno:**
 - Requires further investigation




Conclusions

- **Group sunspot number:**
 - **Average SSN/GSN is station-dependant:**
 - Close to the 12.08 value (Hoyt & Schatten) only for “good” stations reporting the largest sunspot counts (incl. Locarno)
 - Values lower than 12 for most other stations.

SSN/GSN	Cycle Max	Cycle Min
GSN (H&S)	12.08	12.08
Locarno	12.6	8.8
Others	10.4 – 11.3	7.3 – 7.9

SC/GC	Cycle Max	Cycle Min
GSN (H&S)	10.13	10.13
Locarno	11.0	4.7
Others	7.3 – 8.8	2.2 – 3.2


$$(12.6 \times 9.5 + 8.8 \times 1.5) / 11 = 12.08$$



Future developments

- Relation between the SSN/GSN ratio and the personal K coefficient of each station
- Conversion and extension of computing programs in Python language
- **Addition of the raw data from the Zürich network from 1950 to 1981** (except Zürich itself!):
 - ➔ Doubling the length of the reconstruction
 - ➔ Diagnostic of the Zürich series and the Zürich-SIDC transition:
 - Several stations contributing both to the Zürich and SIDC numbers.