Historical Sunspot Database

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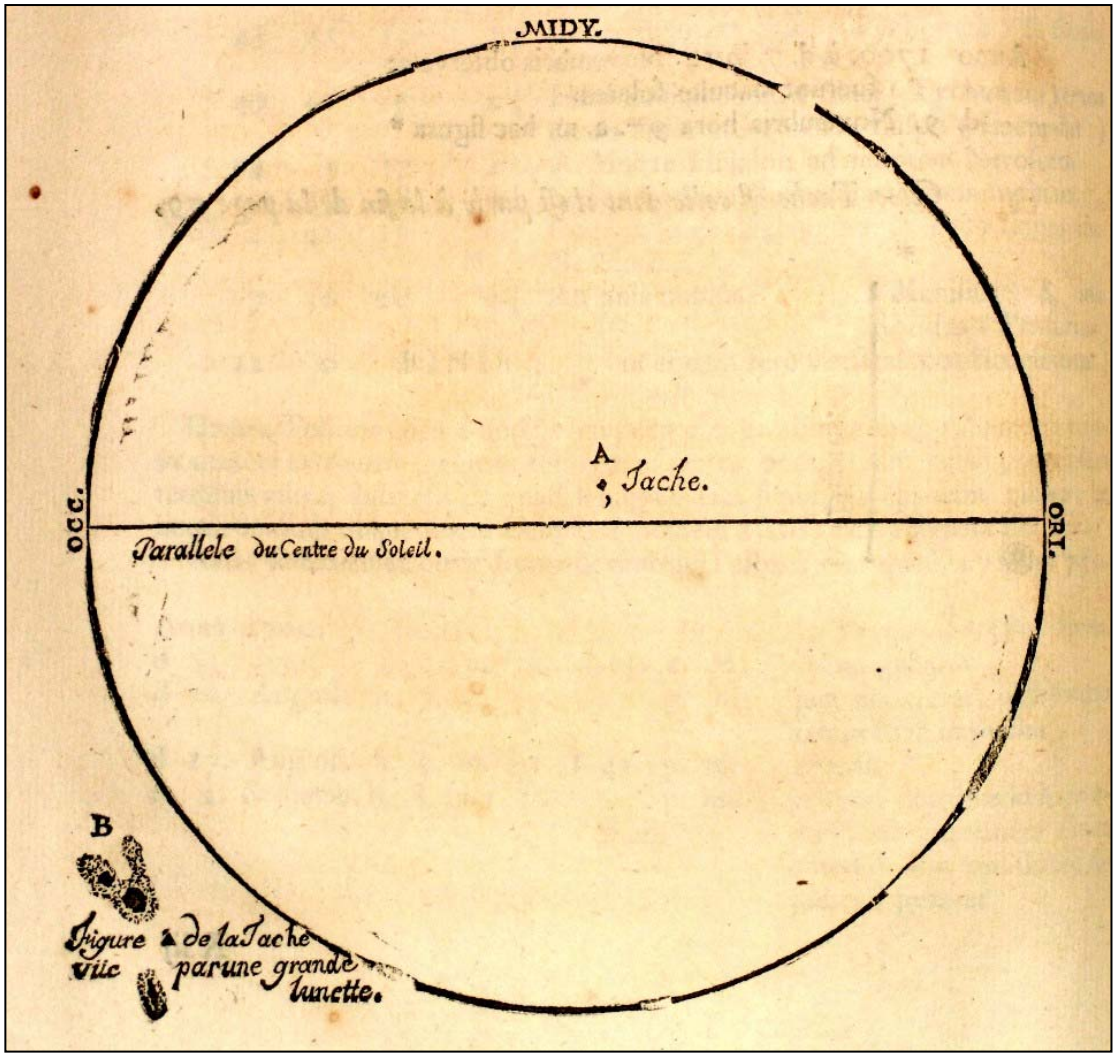


Sunspot observed by Cassini and Maraldi from Montpellier (29 March 1701)

OUTLINE

1. How can we construct a **new version** of SSN?
2. Sunspot database **now**
3. **Some examples** of additions or corrections.

   The onset of the Maunder Minimum

   Drawings by Staudacher (Rainer Arlt)

   Madrid SSN
4. **Quality control**
5. Leif's **breakpoints**
6. Some **proposals**

Addenda: **Annual Averages** of SSN!!!

1. How can we construct a new version of SSN?

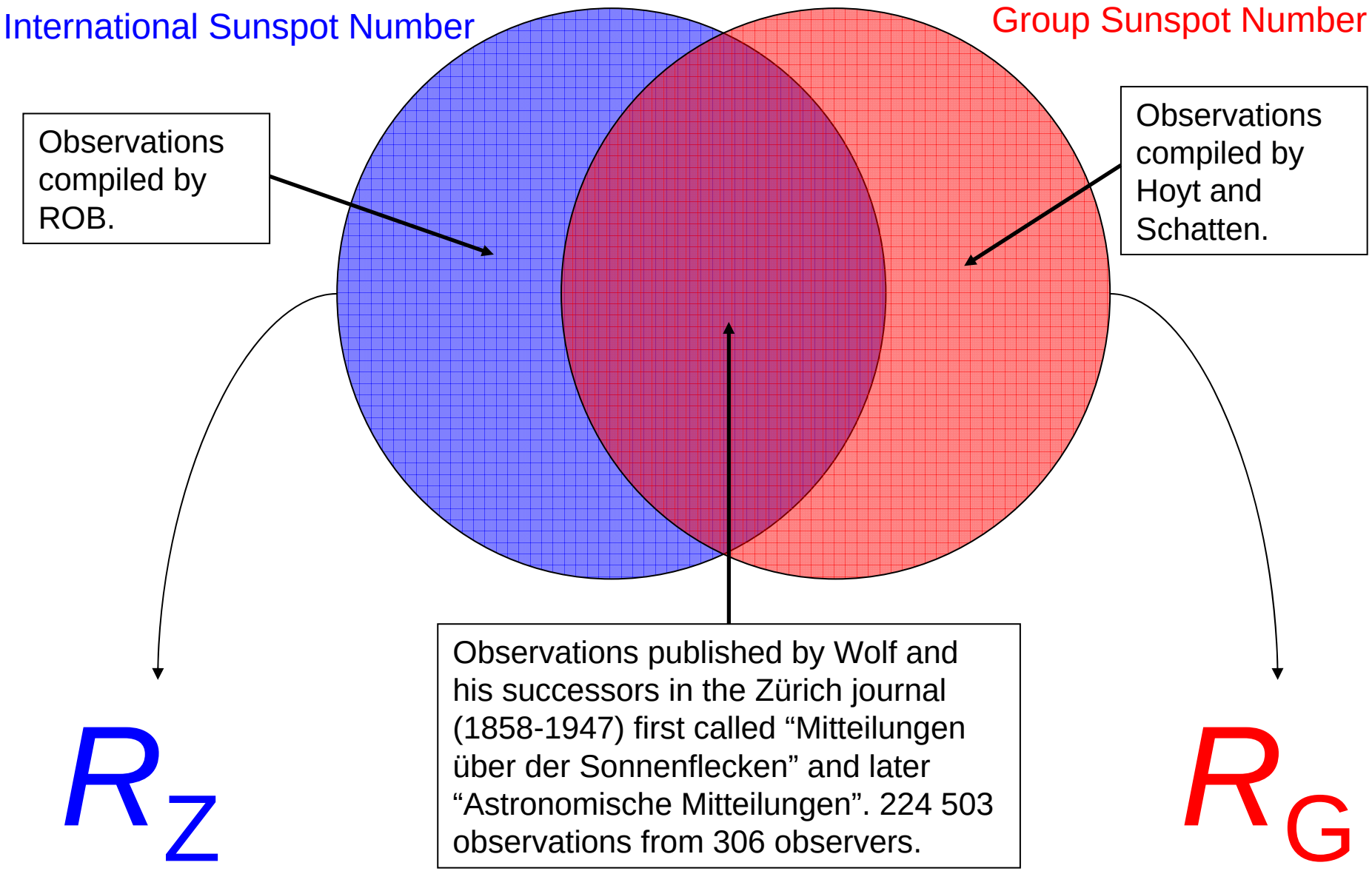
I. Improve the database with old and new observations
   I. Pending tasks (Hoyt & Schatten, 1998)
   II. Rediscovering “lost” records

II. Develop a new methodology to reduce all observations
   I. Computing classical calibration constants (*k*)
   II. New statistical techniques

III. Check our series using different tools
   I. Geomagnetic records (c. 1835) and other proxies
   II. Statistical techniques

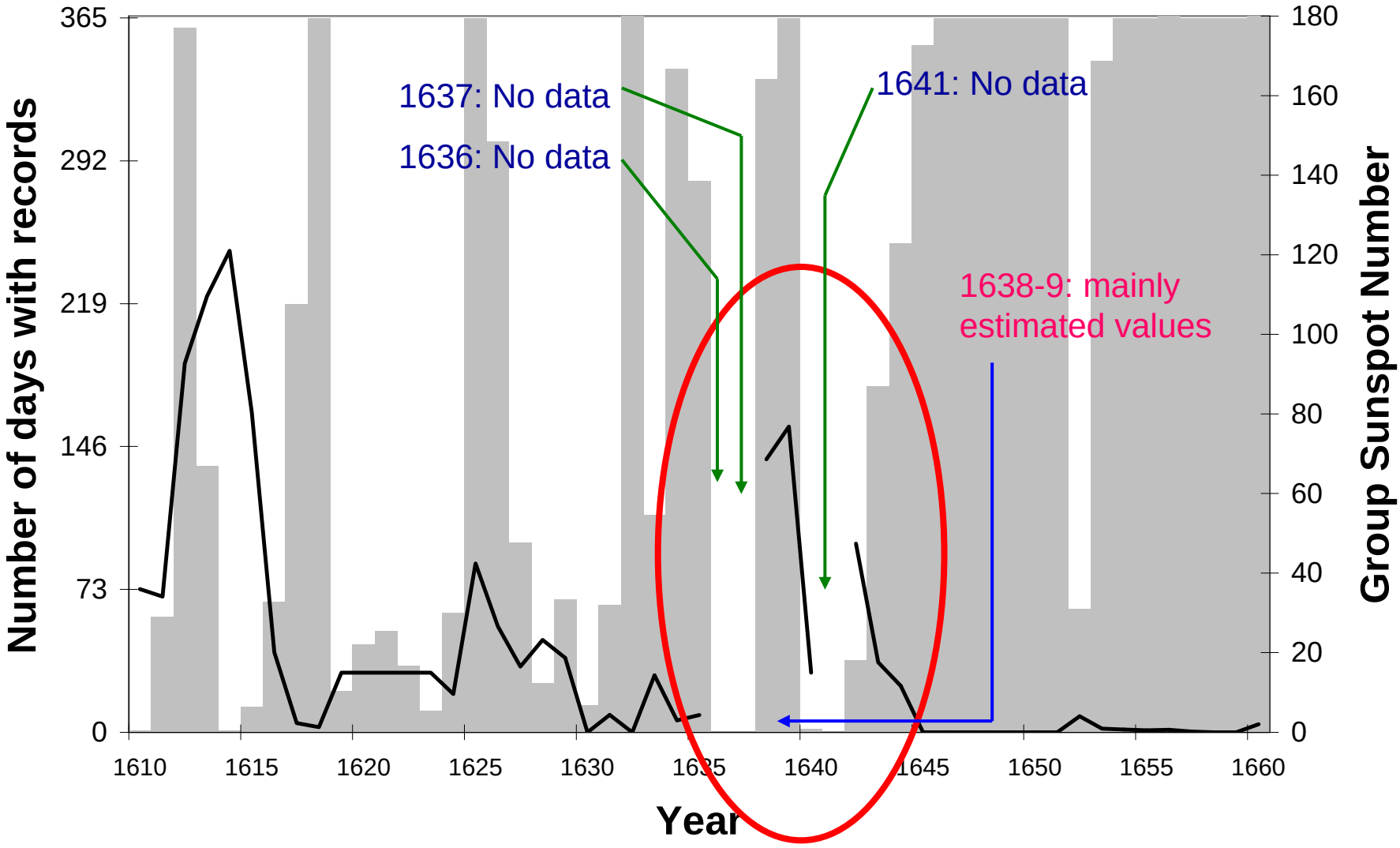
IV. Publish and maintenance of data

2. Sunspot database now



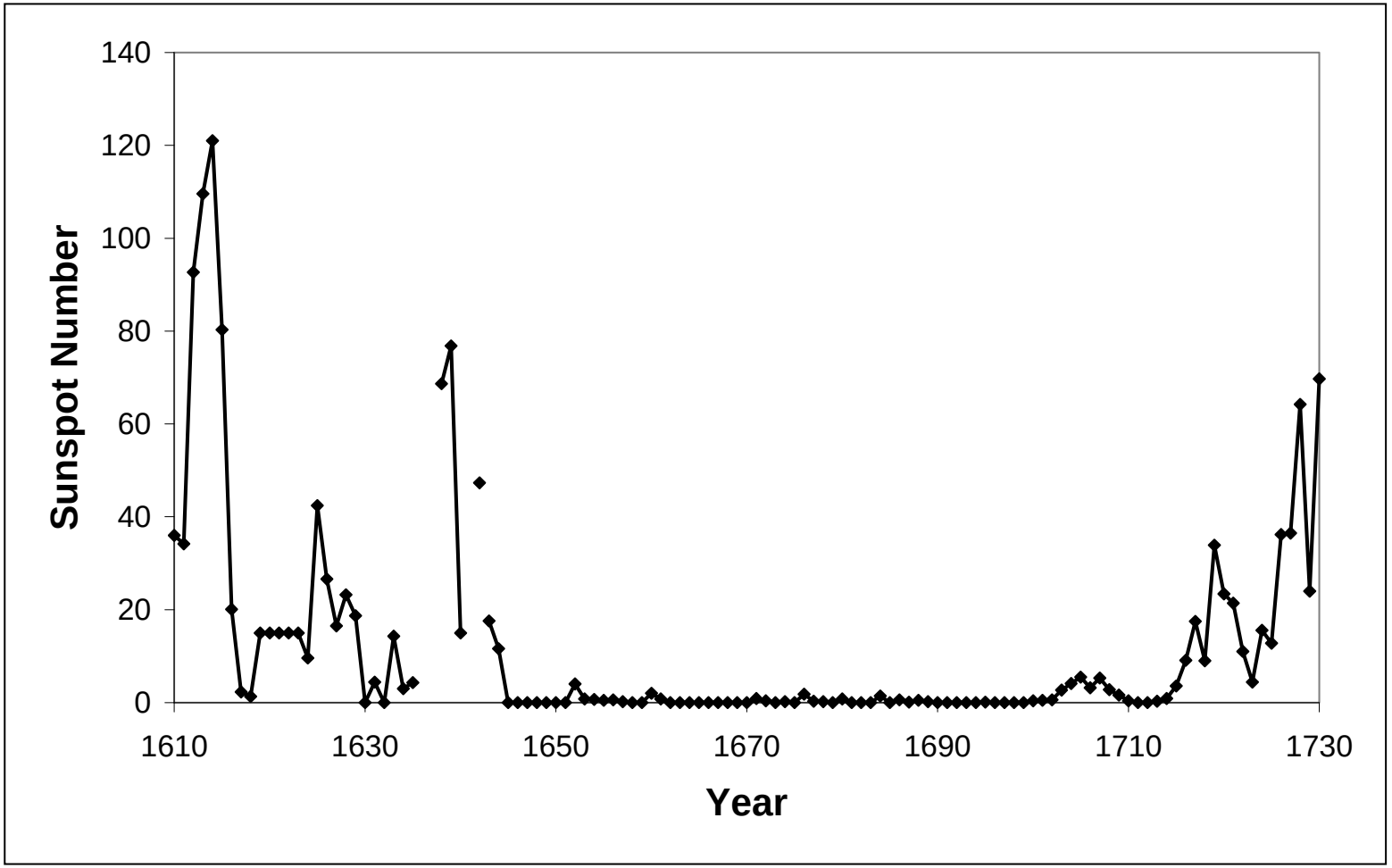
3. Some examples of addition or corrections

3.1. The onset of the Maunder Minimum



Accepted general scenario for Maunder Minimum (Usoskin, 2008):

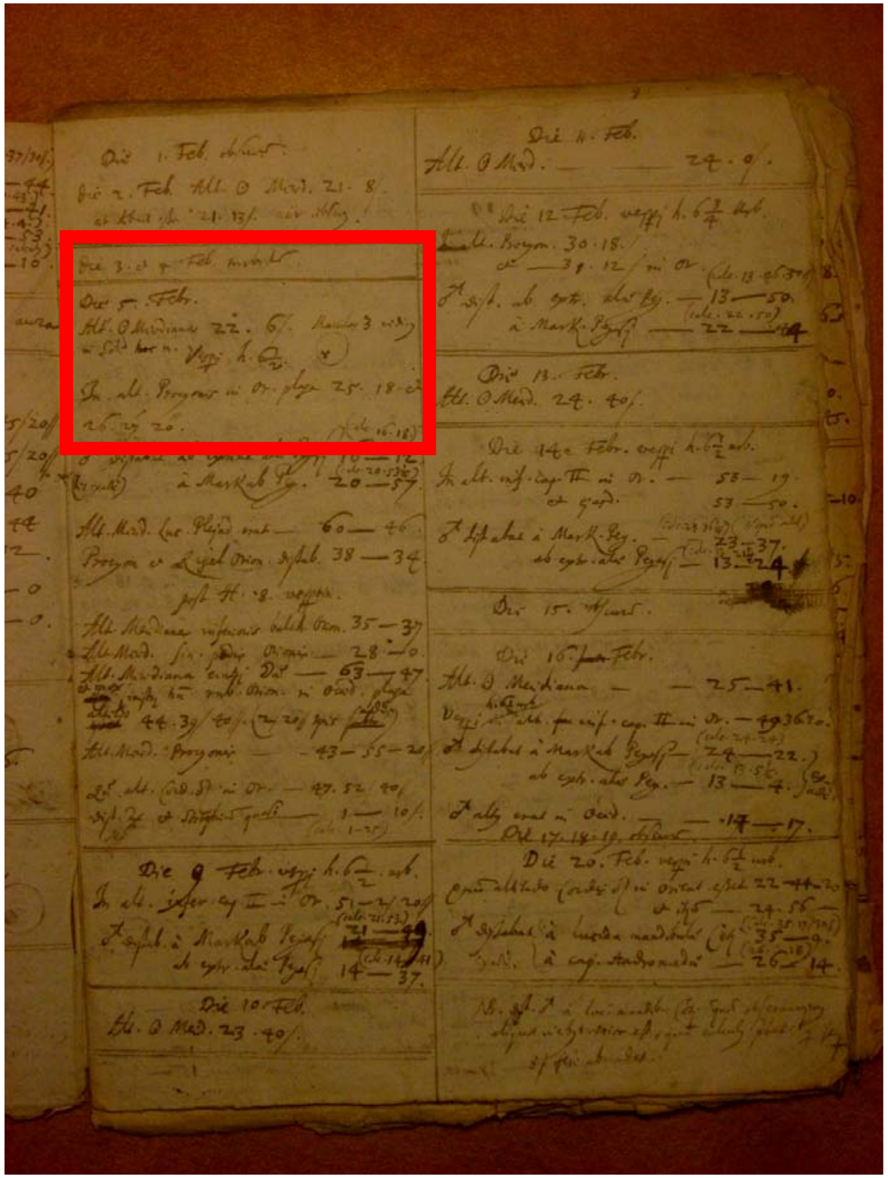
(1) transition from the normal activity to the deep minimum was sudden,
(2) a 22-year cycle was dominant in sunspot, and
(3) the recovery of the sunspot activity from the deep minimum to normal activity was gradual.

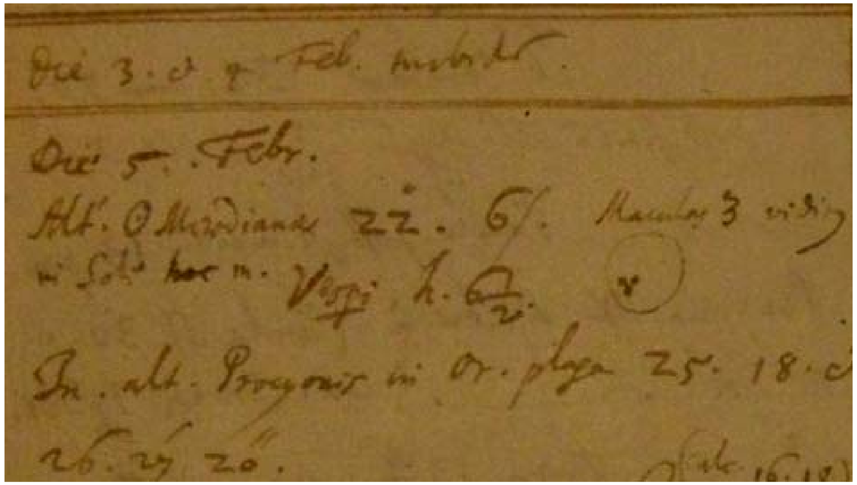


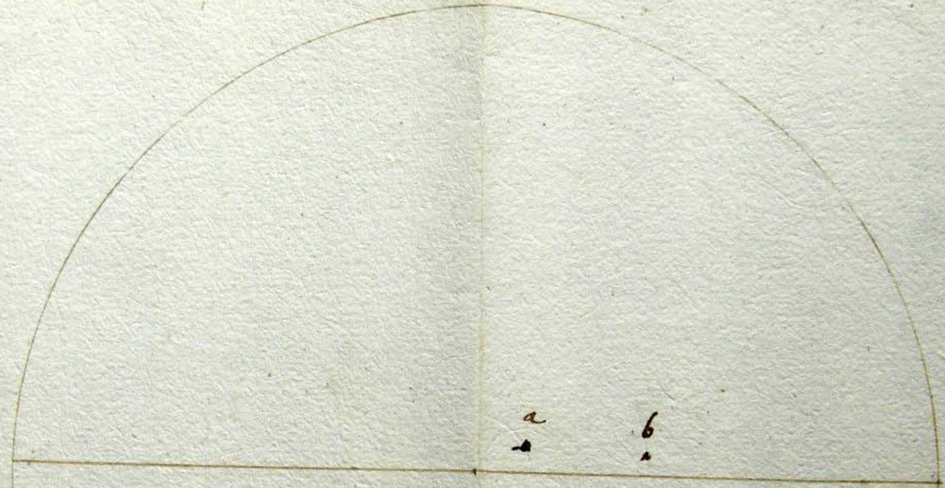
(1) We have added the **Marcgraf sunspot records**

REGIONAAL ARCHIEF LEIDEN

BNP BIBLIOTECA NACIONAL DE PORTUGAL



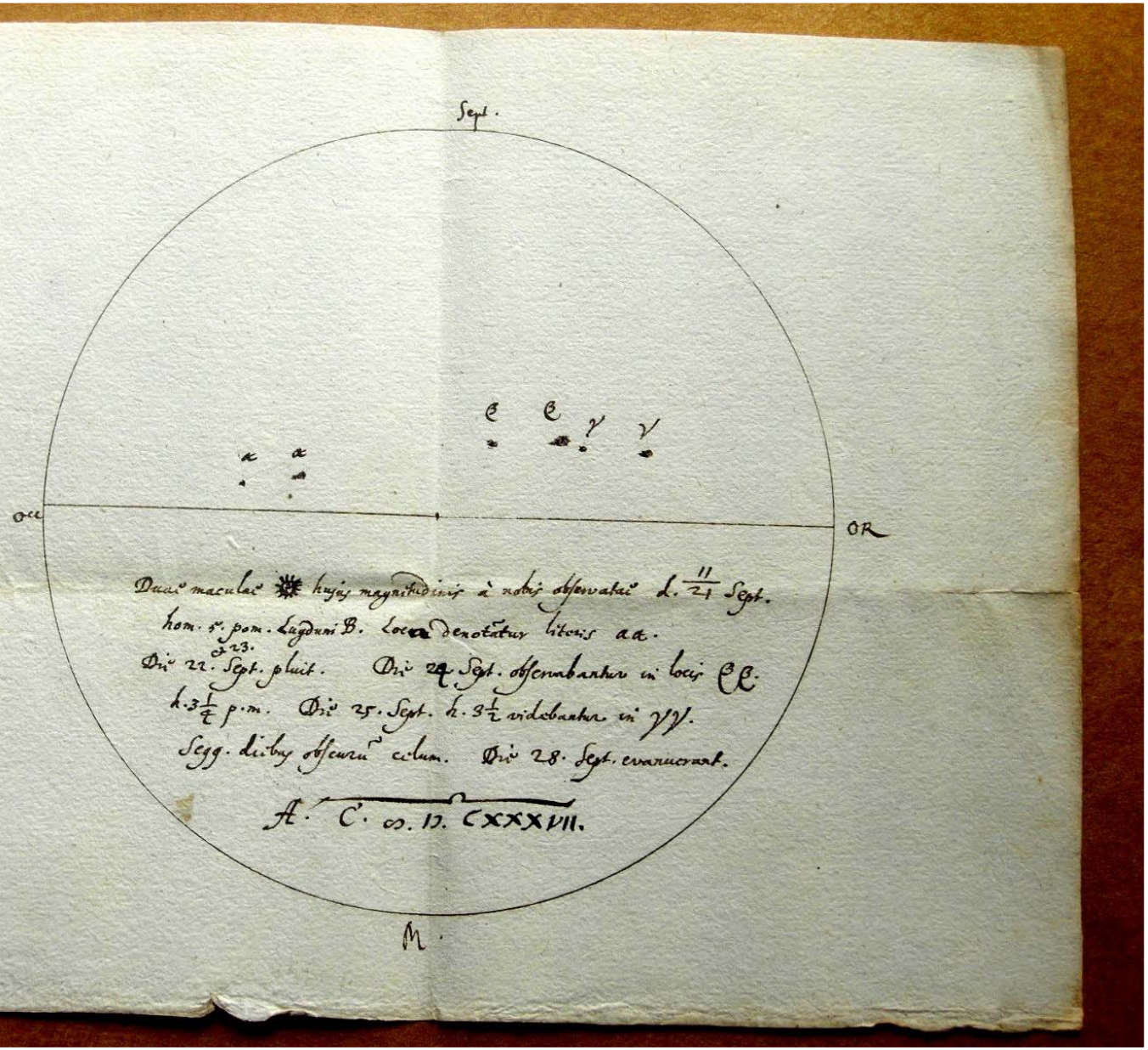

Die 5. Febr.
26. 27 20".



Macula ☉ à nobis observata M. Octob. A. C. CIↃ IↃ CXXXVII. Lugduni Bat.

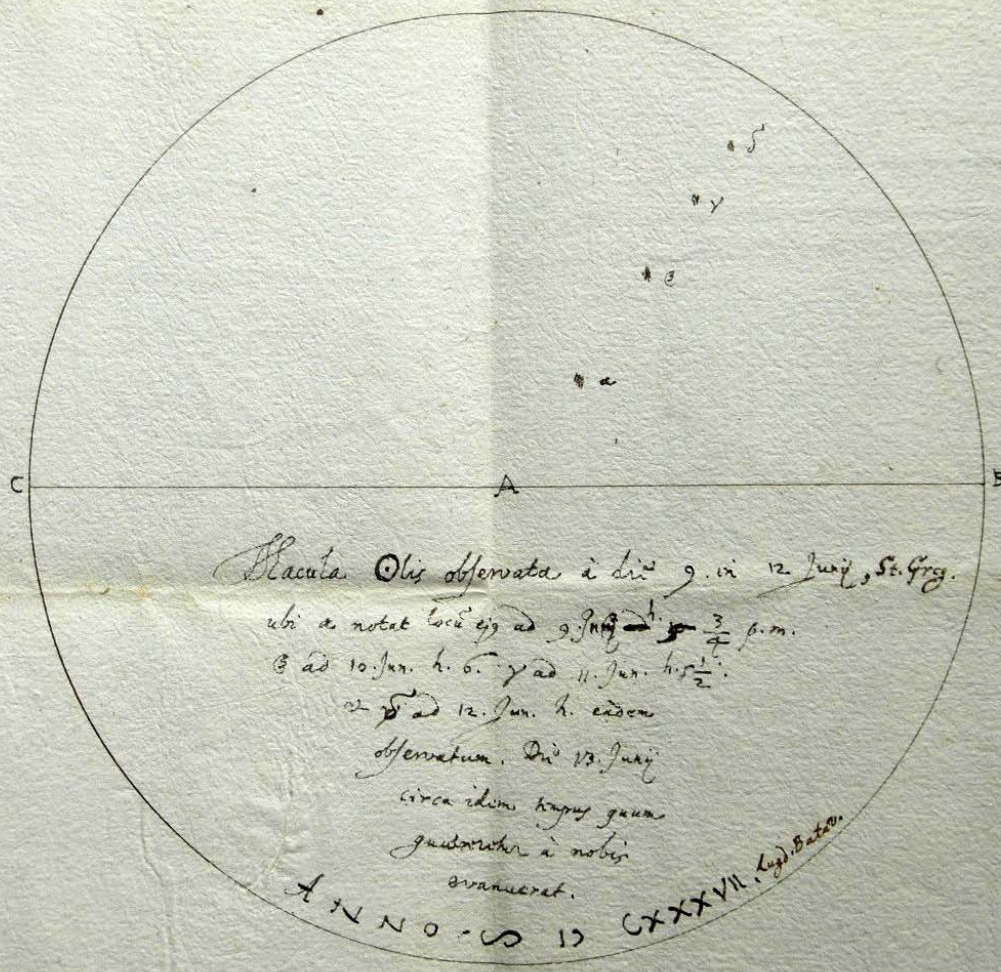
Die 10. Octob. St. Greg. nulla inveniebatur macula. Die 11. erat obscurum cœlum. Die 12. Octob. h. 2½ pom. macula primò inveniebatur in a. Die 13. Octob. h. 3. pom. visa nobis in b, sed exigua, et minor quàm pridie. Die 14 Octob. sine Sole. Die 15. h. 3½ pom. evanuerat, nec videbatur ulterius.

NB [illegible]
[illegible]
39. 8'. 40''.



Duæ maculæ ☼ hujus magnitudinis à nobis observatæ d. 11/21 Sept.
hor. 4ª pom. Lugduni B. Loca denotantur literis αα.
Die 22. Sept. pluit. Die 24. Sept. observabantur in locis ϵϵ.
h. 3 1/2 p.m. Die 25. Sept. h. 3 1/2 videbantur in γγ.
Seqq. diebus obscurum cælum. Die 28. Sept. evanuerant.

A. C. 00. 17. CXXXVII.

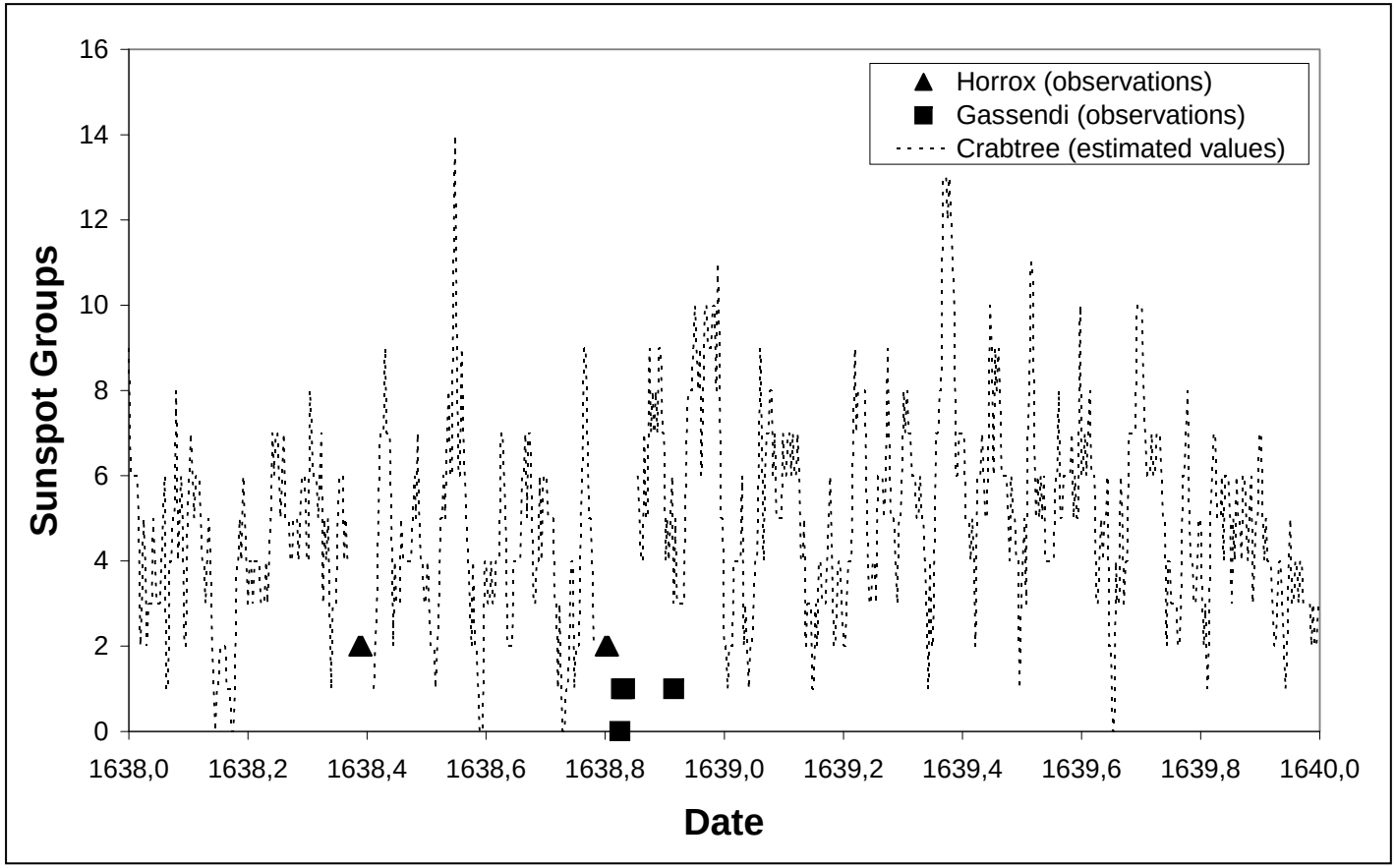


Macula ☉is observata à die 9. in 12. Junij, St. Greg.
ubi a notat locū ejus ad 9. Junij h. [illegible] p.m.
☿ ad 10. Jun. h. 6. ♀ ad 11. Jun. h. 5½.
♂ ♃ ad 12. Jun. h. eadem
observatum. Die 13. Junij
circa idem tempus quem
quotidie à nobis
observatur.

ANNO CIↃ CXXXVII. Lugd. Batav.

(2) We have **eliminated the estimated** (not observed) values from Crabtree's comments (1638-1639).

Hoyt and Schatten (1998) wrote in their Bibliography: ‘‘According to a letter by Crabtree the average number of spot groups seen in 1638 and 1639 were 4–5 per day. The database has Greenwich fill values to give 4–5 groups per day. This substitution technique was used to simplify the analysis. This is the only place in the entire database where we do this type of substitution’’.



Vaquero (2007), Adv Spa Res

(3) We have corrected the dates and the numbers of sunspot groups of Horrox observations in HS98 (**from Julian calendar to Gregorian Calendar**).

JEREMIÆ HORROCCII,

LIVERPOLIENSIS ANGLI, ex Palatinatu LANCASTRIÆ,

OPERA POSTHUMA;

viz.

Aſtronomia *Kepleriana*, defenſa & promota;
Excerpta ex Epiſtolis ad *Crabtræum* ſuum.
Obſervationum Cœleſtium Catalogus.
Lunæ Theoria nova.

Accedunt

GUILIELMI CRABTRÆI, *Manceſtrienſis*,
Obſervationes Cœleſtes.

In calce adjiciuntur

JOHANNIS FLAMSTEDII, *Derbienſis*,
De Temporis Æquatione Diatriba.
Numeri ad Lunæ Theoriam *Horroccianam*.

LONDINI,
Typis GULIELMI GODBID, Impenſis J. MARTYN Regalis Societatis Typographi, ad inſigne Campanæ in Cœmeterio D. *Pauli*, Anno Domini M. D. C. LXXIII.

putaveris te alterum ad Septentrionem, alterum ad Auſtrum conſpexiſſe.

Maii 22, h. 3. P. Radios Solares intromiſi per Tubum Opticum in cameram obſcuratam, (denſis tenebris non opus eſt:) atque in limbo orientali, prope viam regiam (ut puto,) vidi duas nigras maculas. Major diſtabat à Solis margine min. 3′. Maculæ diameter longior erat quaſi min. 30″, brevior quaſi min. 20″, erátque in forma Ovali.

Maii 23, h. 3. P. Major duarum abfuit à margine min. 1, 20″.

Maii 24, h. 3. P. abfuit min. 0, 25″; jámque facta erat minor quàm reliqua, quæ à margine diſtabat min. 1′.

In magna diſtantia erant hæ maculæ colore cæruleo, cum rubro miſto. Et circa Solis diſcum erat circulus cæruleus, inter exteriorem rubrum, & viridem interiorem, ſicut in Iride; ſed pro varia vitri poſitione ſubinde variabantur hi colores.

Eſſet macula illa, ſi rotunda, Venere major, poſſitque Cometæ inſtar eſſe. Si à Sole projiceretur quantum inde Terra diſtat, adinſtar ſtellæ appareret, niſi forſan à Terrâ nimis diſtaret.

Poſt illos tres dies maculas nullas vidi. Tempus eſt ut reverterentur eædem, ſed nubes impediunt obſervationem.

Eſt autem Tubus hic meus ex vulgaribus unus, pretii 2ſ. 6d, contuli tamen cum duobus aut tribus aliis, quos mutuo habui, ſed meo (quantum ego judico) inferioribus.

Hunc modum exiſtimo egregium fore ad obſervandas Eclipſes. Admittit enim diſcum Solarem tantæ magnitudinis in parva diſtantia, ut ferè minuta ſecunda poſſis obſervare; atque lucem ab umbrâ accuratè diſtinguit, ſi ad juſtam longitudinem educatur.

Stellas fixas dum contueor, nihil video aliud quàm radios undecunq; emiſſos, pro vario vitri poſitione ſitus mutantes.

Mars videtur ejuſdem quaſi magnitudinis cum Jove: *Keplerus* tamen & *Lanſbergius* multò majorem faciunt.

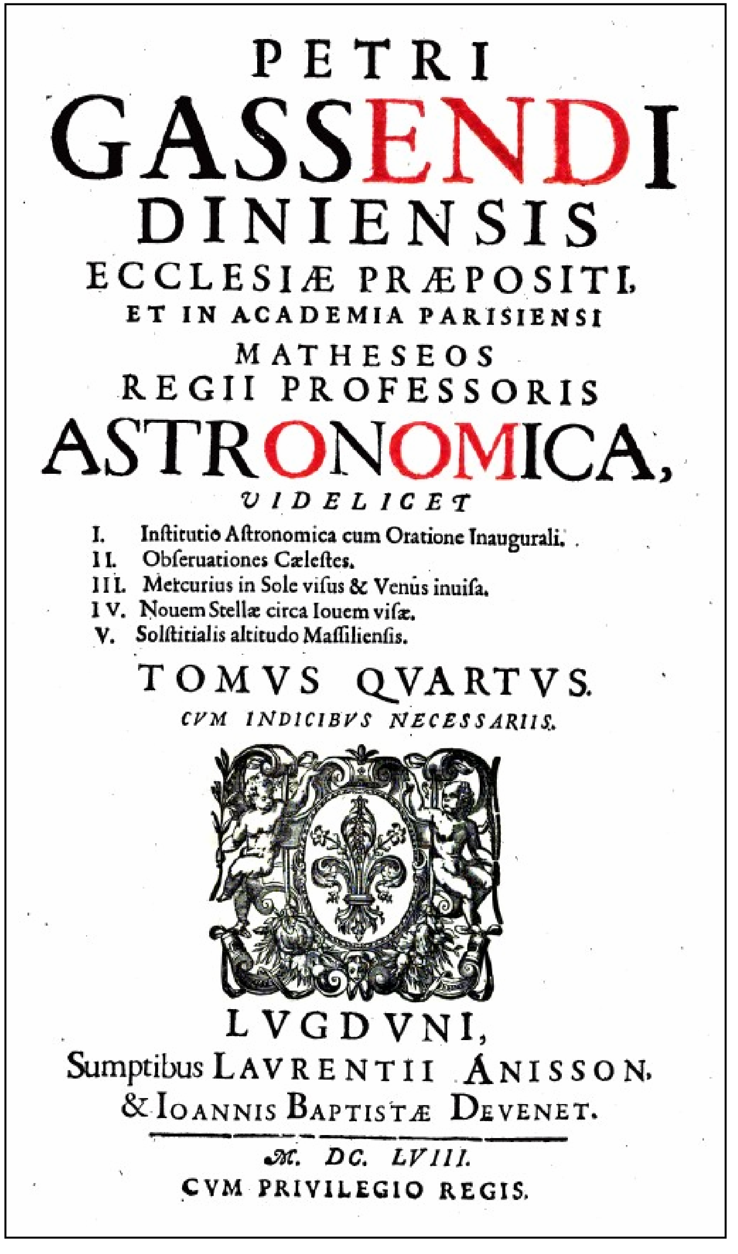
Si Mars ſit Terrâ major, oportet Solis parallaxin multò minorem eſſe quàm vult *Keplerus*.

Ex Epiſt. Julii 25. 1638, Toxtethæ.

POſtquam te viderim, nihil à te accepi, necdum ad te ſcripſi quicquam.

Lingomontanum tandem nactus ſum. Habet ille multas obſervationes Planetarum omnium, præſertim in oppoſitione Solis, ſed breviter deſcriptas.

(4) We have **eliminated one spurious** observation by Gassendi on 1 Dec 1638.

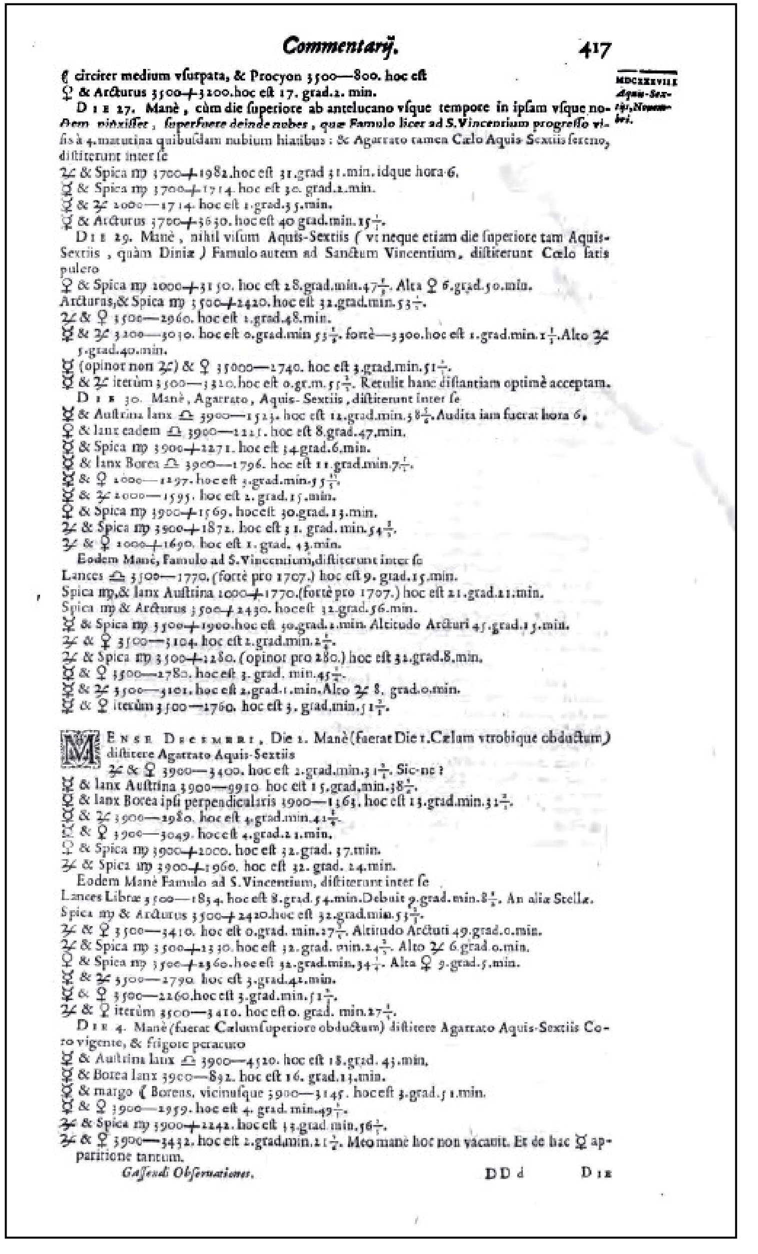


PETRI
GASSENDI
DINIENSIS
ECCLESIÆ PRÆPOSITI,
ET IN ACADEMIA PARISIENSI
MATHESEOS
REGII PROFESSORIS
ASTRONOMICA,
VIDELICET

I. Institutio Astronomica cum Oratione Inaugurali.
II. Obseruationes Cæelestes.
III. Mercurius in Sole visus & Venus inuisa.
IV. Nouem Stellæ circa Iouem visæ.
V. Solstitialis altitudo Massiliensis.

TOMVS QVARTVS.
CVM INDICIBVS NECESSARIIS.

LVGDVNI,
Sumptibus LAVRENTII ANISSON.
& IOANNIS BAPTISTÆ DEVENET.
M. DC. LVIII.
CVM PRIVILEGIO REGIS.



Commentarij. 417

☾ circiter medium vsurpata, & Procyon 3500—800. hoc est
♀ & Arcturus 3500+3200. hoc est 17. grad.2. min.
DIE 27. Manè, cùm die superiore ab antelucano vsque tempore in ipsam vsque noctem pluisset, superfuere deinde nubes, quæ Famulo licet ad S.Vincentium progresso visis à 4. matutina quibusdam nubium hiatibus: & Agarrato tamen Cælo Aquis-Sextiis sereno, distiterunt inter se

MDCXXXVIII. Aquis-Sextiis, Nouembri.

♃ & Spica ♍ 3700+1982. hoc est 31.grad 31.min. idque hora 6.
☿ & Spica ♍ 3700+1714. hoc est 30. grad.2.min.
☿ & ♃ 2000—1714. hoc est 1.grad.35.min.
☿ & Arcturus 3700+3630. hoc est 40 grad.min. 15 1/3.
DIE 29. Manè, nihil visum Aquis-Sextiis (vt neque etiam die superiore tam Aquis-Sextiis, quàm Diniæ) Famulo autem ad Sanctum Vincentium, distiterunt Cælo satis pulcro
♀ & Spica ♍ 2000+3150. hoc est 28.grad.min.47 1/3. Alta ♀ 6.grad.50.min.
Arcturus,& Spica ♍ 3500+2420. hoc est 32.grad.min.53 1/3.
♃ & ♀ 3500—2960. hoc est 1.grad.48.min.
☿ & ♃ 3200—3030. hoc est 0.grad.min 55 1/2. fortè—3300. hoc est 1.grad.min.1 1/3. Alto ♃ 5.grad.40.min.
☿ (opinor non ♃) & ♀ 35000—2740. hoc est 3.grad.min.51 1/3.
☿ & ♃ iterùm 3500—3310. hoc est 0.gr.m.55 2/3. Retulit hanc distantiam optimè acceptam.
DIE 30. Manè, Agarrato, Aquis-Sextiis, distiterunt inter se
☿ & Austrina lanx ♎ 3900—1523. hoc est 12.grad.min.58 5/6. Audita iam fuerat hora 6.
♀ & lanx eadem ♎ 3900—2221. hoc est 8.grad.47.min.
☿ & Spica ♍ 3900+2271. hoc est 34.grad.6.min.
☿ & lanx Borea ♎ 3900—1796. hoc est 11.grad.min.7 1/3.
☿ & ♀ 2000—1297. hoc est 3.grad.min.55 1/3.
☿ & ♃ 2000—1595. hoc est 2.grad.15.min.
♀ & Spica ♍ 3900+1569. hoc est 30.grad.13.min.
♃ & Spica ♍ 3500+1872. hoc est 31. grad. min.54 2/3.
♃ & ♀ 2000+1690. hoc est 1. grad. 43.min.
Eodem Manè, Famulo ad S.Vincentium,distiterunt inter se
Lances ♎ 3500—1770. (fortè pro 1707.) hoc est 9. grad.15.min.
Spica ♍,& lanx Austrina 2000+1770.(fortè pro 1707.) hoc est 21.grad.21.min.
Spica ♍ & Arcturus 3500+2430. hoc est 32.grad.56.min.
☿ & Spica ♍ 3500+1900. hoc est 30.grad.1.min. Altitudo Arcturi 45.grad.15.min.
♃ & ♀ 3500—3104. hoc est 1.grad.min.2 1/2.
♃ & Spica ♍ 3500+2280. (opinor pro 280.) hoc est 32.grad.8.min.
☿ & ♀ 3500—2780. hoc est 3. grad. min.45 1/2.
☿ & ♃ 3500—3101. hoc est 2.grad.1.min. Alto ♃ 8. grad.0.min.
☿ & ♀ iterùm 3500—1760. hoc est 3. grad.min.51 2/3.

MENSE DECEMBRI, Die 1. Manè (fuerat Die 1. Cælum vtrobique obductum) distitere Agarrato Aquis-Sextiis
♃ & ♀ 3900—3400. hoc est 2.grad.min.31 1/3. Sic-ne?
☿ & lanx Austrina 3900—9910 hoc est 15.grad.min.38 1/2.
☿ & lanx Borea ipsi perpendicularis 3900—1363. hoc est 13.grad.min.31 2/3.
☿ & ♃ 3900—2980. hoc est 4.grad.min.41 1/2.
☿ & ♀ 3900—3049. hoc est 4.grad.21.min.
♀ & Spica ♍ 3900+2000. hoc est 32.grad. 37.min.
♃ & Spica ♍ 3900+1960. hoc est 32. grad. 24.min.
Eodem Manè Famulo ad S.Vincentium, distiterunt inter se
Lances Libræ 3500—1834. hoc est 8.grad.54.min. Debuit 9.grad.min.8 1/2. An aliæ Stellæ.
Spica ♍ & Arcturus 3500+2420. hoc est 32.grad.min.53 1/3.
♃ & ♀ 3500—3410. hoc est 0.grad. min.27 1/3. Altitudo Arcturi 49.grad.0.min.
♃ & Spica ♍ 3500+2330. hoc est 32. grad. min.24 2/3. Alto ♃ 6.grad.0.min.
♀ & Spica ♍ 3500+2360. hoc est 32.grad.min.34 1/3. Alta ♀ 9.grad.5.min.
☿ & ♃ 3500—2790. hoc est 3.grad.42.min.
☿ & ♀ 3500—2260. hoc est 3.grad.min.51 1/3.
♃ & ♀ iterùm 3500—3410. hoc est 0. grad. min.27 1/3.
DIE 4. Manè (fuerat Cælum superiore obductum) distitere Agarrato Aquis-Sextiis Coro vigente, & frigore peracuto
☿ & Austrina lanx ♎ 3900—4520. hoc est 18.grad. 43.min.
☿ & Borea lanx 3900—832. hoc est 16. grad.13.min.
☿ & margo ☾ Boreus, vicinusque 3900—3145. hoc est 3.grad.51.min.
☿ & ♀ 3900—2959. hoc est 4. grad. min.49 1/3.
♃ & Spica ♍ 3900+2242. hoc est 33.grad. min.56 1/3.
♃ & ♀ 3900—3432. hoc est 2.grad.min.21 1/2. Meo manè hoc non vacauit. Et de hac ☿ apparitione tantum.

Gassendi Obseruationes. DDd DIE

(5) We have changed the **record by Rheita** [1642].

OCVLVS ENOCH ET ELIÆ

SIVE

RADIVS SIDEREOMYSTICVS

PARS PRIMA

AVTHORE

R·P·F· ANTONIO MARIA SCHYRLEO DE RHEITA

ORD. CAPVCINORVM CONCIONAT. ET PROVINCIÆ AVSTRIÆ AC BOHEMIÆ QVONDAM PRÆLECTORE.

Opus Philoſophis, Aſtronomis, & rerum cæleſtium æquis æſtimatoribus non tam vtile quàm iucundum:

Quo omnium Planetarum veri motus, ſtationes, & retroceſsiones, ſine vllis epicyclis & æquantibus, tam in Theoria Tychonica, quàm Copernicana compendioſſiſimè & iucundiſsimè demonſtrantur exhibenturque. Hypotheſis Tychonis quoad abſolutam veritatem ſtabilitur ac facilior ipsâ Copernicanâ redditur, reformatur, & ad ſimpliciſſimam normam & formam reducitur.

HISCE ACCESSERVNT

Nouæ harmonicæ determinationes molium & proportionum Planetarum ad inuicem. Item plurimæ aliæ nouitates cælo ab Auctore deductæ. Probabiliſſima cauſa fluxus & refluxus Oceani. Ratio breuis conficiendi Teleſcopium aſtronomicum. Et vltimò Planetologium mechanicum & nouum, quo pauciſſimis rotis veri omnium Planetarum motus iucundè exhiberi queunt.

Quia delectaſti me Domine in factura tua: & in operibus manuum tuarum exultabo. Pſ. 91.

ANTVERPIÆ,
Ex Officina Typographica HIERONYMI VERDVSSII.
M. DC. XLV.

& Sol morbo illo palloris, & ſæculum triſtiori caligne laborarint. Idem ſub Conſtantino Principe, & Irene contigiſſe ferunt circa annum Chriſti 797. Quorum tempore per 17. integros dies, adeò nuſquam viſus eſt Sol, adeò tenues radios telluri immiſit, vt mundo aut omninò abreptus, aut certè radijs & gratiſsimâ luce ſpoliatus exutusque crederetur. Enimverò in vaſtiſsimo tunc oceano oberrantes, neque curſum ſuum per tenebras dirigere, neque telluri inſiſtentes cœptum iter & negotiationes humanas proſequi potuerunt.

Iterum Anno 1547. per totam vaſtiſsimam Europæ plagam, Solis radij ſanguineo colore adeò deleti videbantur trium dierum ſpatio; vt mundo vltimum iam quaſi inciperent prænũtiare diem. Denique tempore, quo Rudolphus II. Auguſtus ex humanis abreptus fuerat, Solem per plures dies, ſuâ triſtiſsima facie & luce obfuſcata ingentem terricolis denuò metum & horrorem incuſsiſſe ferunt.

Quidam Solem ſimilem monti Æthnæ putant.

Horum igitur ſolarium prodigiorum meritò cauſam indagare liceat. Aliqui putant Solem inſtar alterius montis Æthnæ, aut Veſuuij recrementa ſua in extimam ſuperficiem proflare, & veluti pluuiâ fauillarum inde adeò conſpergi & vndique circumdari, vt mundo inde quaſi eripiatur dies, ſplendore omni Solis intercepto, donec eructante flammâ agmen illud fauillarum ab extima ſuperficie diſpergatur, aut fauillæ depaſcantur. Quæ ſententia, ſi Solis ignis ſupponatur alimento & pabulo foueri, fortè aliquid probabilitaris obtineret. Quod ſi verò Sol, velut puriſsimum elementum & impermixtus ignis, pabulo nullo indigeat, ſed diuinæ potentiæ, voluntatis & conſeruationis vis ei vtique, vt conſeruetur ſufficiat; non video vnde Soli illa recrementa, & vſtrina materia prouenire queat.

Fortè haud etiam ineptè talium accidentium ratio aſsignari poſſet; ſcilicet ſi dicamus Soli frequentem illum luorem & pallorem, ex macularum, ſeu ſtellarum ſolarium nimiùm quãdoque concurrentiũ agmine cõtingere. Adeò enim quandoque diſcus ſolaris dictis ſtellis & maculis ſcatet, vt mirum haud ſit eius inde lumen notabiliſsimè hebetari debilitarique.

Certè quod iam diximus, propria experientiâ Coloniæ Anno 1642. experti ſumus: dum ingentem ſtellarum ſolarium turmam maiorum & minorum per 14. dies & vltra ſibi inuicem continuâ ſerie ſuccedentium cum ſtupore, ſolarem diſcum adeò occupare vidimus, vt lux eius, maximè media, & intenſiſsima, haud leuiter illis fuerit hebetata. Nam tubo optimo, in medio ſolaris diſci globum perfectiſsimè rotundum, ſubnigrum,

ſubnigrum, pugni magnitudinem quaſi excedentem conſpeximus, idque directiſsimo aſpectu; qui & per octiduum Solis haud exiguam portioné eclipſauit: maximaſque aëri turbationes, vtpotè ventos, imbres, & frigora in medio Iunij attulit: prout crebris obſeruationibus iam à multis annis compertum habemus: ſcilicet ferè ſemper aëris inſigniores, & magis notabiles mutationes ex dictarum ſtellarum ſolarem diſcum ſubeuntium agmine contingere & euenire.

Maculæ ſub Sole aëris mutationem cauſant.

Et profecto perfalſum eſt, maculas illas penitiori obtutu directè per optimum & longiorem tubum aſtronomicum, (qui totum ſimul ſolarem diſcum diſcoperiat exhibeatque) conſpectas, aliam quàm circulariſsimam & rotundam figuram oſtendere, vt frequenter experti ſumus. Itaque toties ſemper ſolares eclipſes contingere neceſſe eſt, quoties ſtellæ dictæ Solem ſubeunt; ſubeunt autem frequentiſsimè; ergo multò frequentiores & plures contingunt nobis ſolares eclipſes, quàm vulgus arbitratur. Sed quis obſecro talium eclipſium arcanos reſpectu telluris noſtræ effectus hactenus penetrauit? vt quid ergo paupelli illi deceptores Aſtrologi, ex aſtris de futuris contingentibus diuinare non erubeſcunt, cùm multa præſentia in aſtris ignorent ſidera & ita cæcis & falſis ſuis prognoſticis procedant, ac ſi dicta aſtra aut penitus in rerum natura non eſſent; aut ſine influxu eſſent.

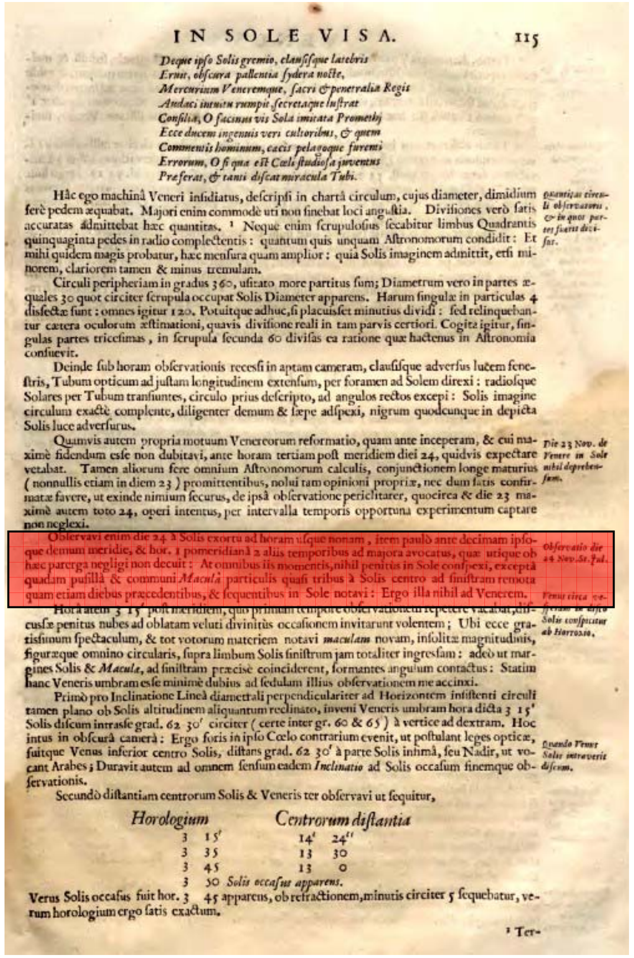
Reprehenduntur Aſtrologi iudiciarij.

An non inſipientem medicum illum iudicares, qui aut ignoratis penitus, aut ſaltem non attentis interioribus humani corporis mẽbris, eorumque in totum animale corpus naturali & neceſſario influxu; ex ſola inferiorum quorundam inſpectione patienti, longiorem, aut breuiorem vitam præſumeret vaticinare, longiturnum morbum, fortunam & ſimilia? Quâ ergo ratione dictorũ Aſtrologorum pleraque cœli nobiliſsima aſtra eorumque in inferiora influxus & energiam, aut omninò ignorantium, aut ſaltem vix vmbram virtutum illorũ cognoſcentiũ turma cæcò iudicio, & prognoſticis ſuis fictis tantopere hodie mundum excæcare, homineſque inanibus ac mendacibus verbis cæco quaſi verbere ferire non dubitat? Cumque ſemper æquiuocè mentiantur prognoſticando; mirum non eſt ea quæ alias reuerâ caſu tantùm contingunt quandoque, etſi præter intentioné prognoſticantium, accidere, ſicque prædictionibus eorum à ſimplicioribus fidem haberi. Certè ipſo ſtatim fronte æquiuoco prædictionum ſuarum produnt, à quo talem diuinationem, ſcientiã, aut veriùs inſipientiam ſuam hauriant; ſcilicet non niſi ab illo, (puta diabolo) qui hoc ipſiſsimo modo quondam famoſum illud & no-

(6) We have **incorporated a sunspot record** by Horrox in 4 December 1639.

JOHANNIS HEVELII
MERCURIUS
In Sole visus Gedani,
Anno Christiano M DC LXI, d. III Maji, St. n.
Cum aliis quibusdam rerum Cœlestium observationibus, rarisq; phænomenis.
Cui annexa est,
VENUS
In Sole pariter visa, Anno 1639, d. 24 Nov. St. V.
LIVERPOLIÆ, A JEREMIA HORROXIO:
NUNC PRIMUM EDITA, NOTISQUE ILLUSTRATA.
Quibus accedit succincta
HISTORIOLA,
Novæ illius, ac miræ Stellæ in collo Ceti, certis anni temporibus clarè admodùm affulgentis, rursùs omninò evanescentis.
Nec non
GENUINA DELINEATIO,
Paraselenarum, & Pareliorum quorundam rarissimorum.

Cum Privilegio Sac. Cæsareæ, & Regiæ P. & S. Majestatum
GEDANI,
AUTORIS TYPIS, ET SUMPTIBUS,
imprimebat SIMON REINIGER.
ANNO M DC LXII.



IN SOLE VISA. 115

Deque ipso Solis gremio, clausisque latebris
Eruit, obscura pallentia sydera nocte,
Mercurium Veneremque, sacri & penetralia Regis
Audaci intuitu rumpit secretaque lustrat
Consilia, O facinus vis Sola imitata Promethei
Ecce ducem ingenuis veri cultoribus, & quem
Commentis hominum, cæcis pelagoque furenti
Errorum, O si qua est Cœli studiosa juventus
Præferas, & tanti discat miracula Tubi.

Hâc ego machinâ Veneri insidiatus, descripsi in chartâ circulum, cujus diameter, dimidium ferè pedem æquabat. Majori enim commodè uti non sinebat loci angustia. Divisiones verò satis accuratas admittebat hæc quantitas. [1] Neque enim scrupulosius secabitur limbus Quadrantis quinquaginta pedes in radio complectentis: quantum quis unquam Astronomorum condidit: Et mihi quidem magis probatur, hæc mensura quam amplior: quia Solis imaginem admittit, etsi minorem, clariorem tamen & minus tremulam. *Quantitas circuli observatorii, & in quot partes fuerit divisus.*

Circuli peripheriam in gradus 360, usitato more partitus sum; Diametrum vero in partes æquales 30 quot circiter scrupula occupat Solis Diameter apparens. Harum singulæ in particulas 4 dissectæ sunt: omnes igitur 120. Potuitque adhuc, si placuisset minutius dividi: sed relinquebantur cætera oculorum æstimationi, quavis divisione reali in tam parvis certiori. Cogita igitur, singulas partes tricesimas, in scrupula secunda 60 divisas ea ratione quæ hactenus in Astronomia consuevit.

Deinde sub horam observationis recessi in aptam cameram, clausisque adversus lucem fenestris, Tubum opticum ad justam longitudinem extensum, per foramen ad Solem direxi: radiosque Solares per Tubum transiuntes, circulo prius descripto, ad angulos rectos excepi: Solis imagine circulum exactè complente, diligenter demum & sæpe adspexi, nigrum quodcunque in depicta Solis luce adversurus.

Quamvis autem propria motuum Venereorum reformatio, quam ante inceperam, & cui maximè fidendum esse non dubitavi, ante horam tertiam post meridiem diei 24, quidvis expectare vetabat. Tamen aliorum fere omnium Astronomorum calculis, conjunctionem longe maturius (nonnullis etiam in diem 23) promittentibus, nolui tam opinioni propriæ, nec dum satis confirmatæ favere, ut exinde nimium securus, de ipsâ observatione periclitarer, quocirca & die 23 maximè autem toto 24, operi intentus, per intervalla temporis opportuna experimentum captare non neglexi. *Die 23 Nov. de Venere in Sole nihil deprehensum.*

Observavi enim die 24 à Solis exortu ad horam usque nonam, item paulò ante decimam ipsoque demum meridie, & hor. 1 pomeridianâ 2 aliis temporibus ad majora avocatus, quæ utique ob hæc parerga negligi non decuit: At omnibus iis momentis, nihil penitùs in Sole conspexi, exceptâ quadam pusillâ & communi *Maculà* particulis quasi tribus à Solis centro ad sinistram remota quam etiam diebus præcedentibus, & sequentibus in Sole notavi: Ergo illa nihil ad Venerem. *Observatio die 24 Nov. St. Jul.*

Horâ atem 3 15' post meridiem, quo primum tempore observationem repetere vacabat, discussæ penitus nubes ad oblatam veluti divinitùs occasionem invitarunt volentem; Ubi ecce gratissimum spectaculum, & tot votorum materiem notavi *maculam* novam, insolitæ magnitudinis, figuræque omnino circularis, supra limbum Solis sinistrum jam totaliter ingressam: adeò ut margines Solis & *Maculæ*, ad sinistram præcisè coinciderent, formantes angulum contactus: Statim hanc Veneris umbram esse minimè dubius ad sedulam illius observationem me accinxi. *Venus circa vesperam in disco Solis conspicitur ab Horroxio.*

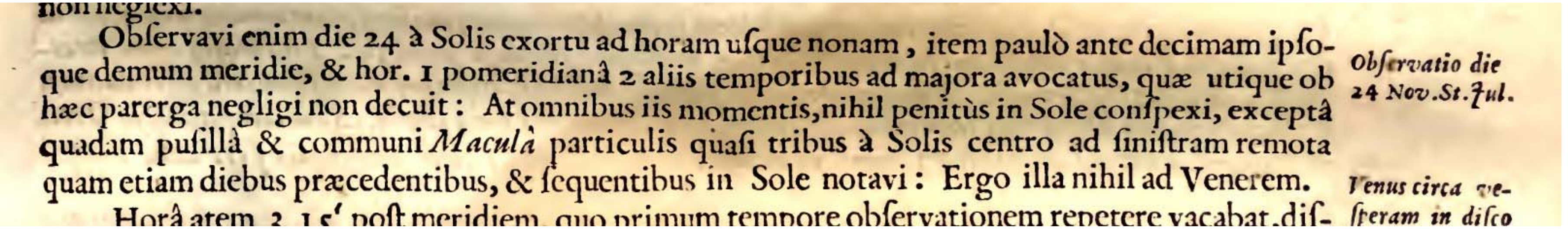
Primò pro Inclinatione Lineâ diametrali perpendiculariter ad Horizontem insistenti circuli tamen plano ob Solis altitudinem aliquantum reclinato, inveni Veneris umbram hora dicta 3 15' Solis discum intrasse grad. 62 30' circiter (certe inter gr. 60 & 65) à vertice ad dextram. Hoc intus in obscurâ camerâ: Ergo foris in ipso Cœlo contrarium evenit, ut postulant leges opticæ, fuitque Venus inferior centro Solis, distans grad. 62 30' à parte Solis infimâ, seu Nadir, ut vocant Arabes; Duravit autem ad omnem sensum eadem *Inclinatio* ad Solis occasum finemque observationis. *Quando Venus Solis intraverit discum.*

Secundò distantiam centrorum Solis & Veneris ter observavi ut sequitur,

Horologium		*Centrorum distantia*	
3	15'	14'	24''
3	35	13	30
3	45	13	0
3	50	*Solis occasus apparens.*	

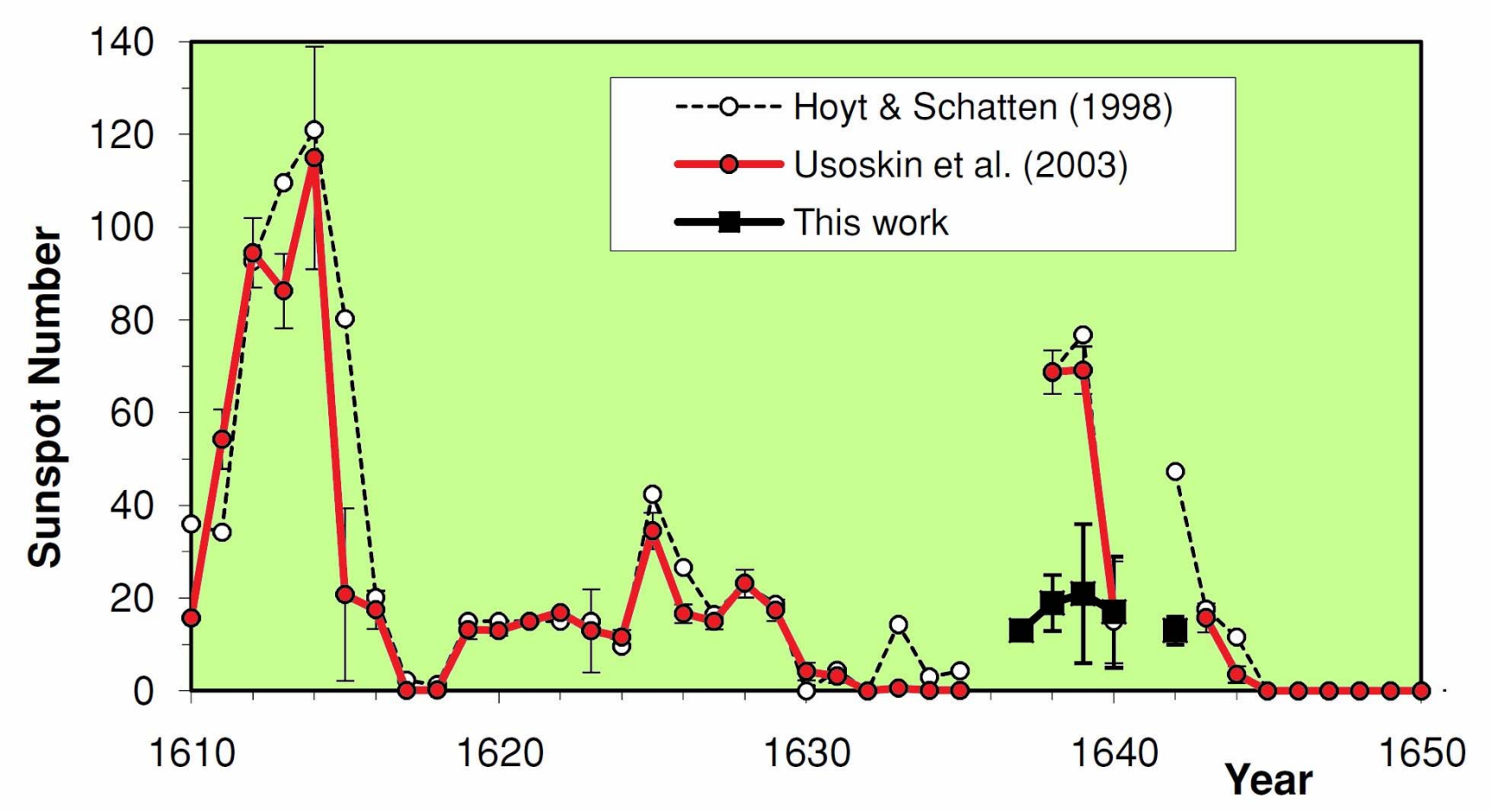
Verus Solis occasus fuit hor. 3 45 apparens, ob refractionem, minutis circiter 5 sequebatur, verum horologium ergo satis exactum.

[1] Ter-



non neglexi.
Observavi enim die 24 à Solis exortu ad horam usque nonam, item paulò ante decimam ipsoque demum meridie, & hor. 1 pomeridianâ 2 aliis temporibus ad majora avocatus, quæ utique ob hæc parerga negligi non decuit: At omnibus iis momentis, nihil penitùs in Sole conspexi, exceptâ quadam pusillâ & communi *Maculà* particulis quasi tribus à Solis centro ad sinistram remota quam etiam diebus præcedentibus, & sequentibus in Sole notavi: Ergo illa nihil ad Venerem. *Observatio die 24 Nov. St. Jul.*
Horâ atem 3 15' post meridiem, quo primum tempore observationem repetere vacabat, dis- *Venus circa vesperam in disco*

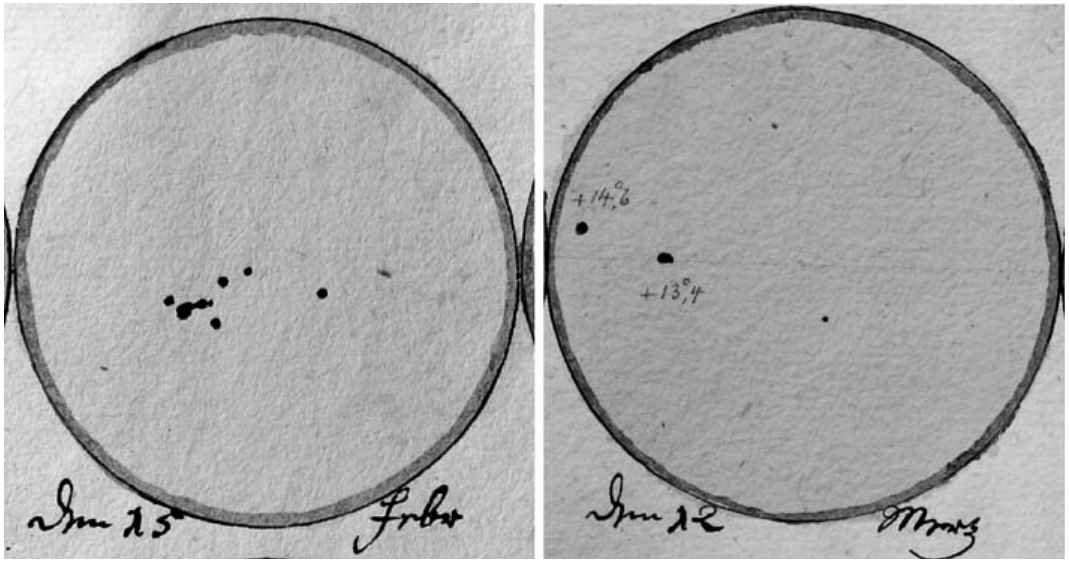
We can use a statistical procedure (Usoskin, Mursula & Kovaltsov, 2003) to reconstruct yearly group sunspot number from sparse daily observation.



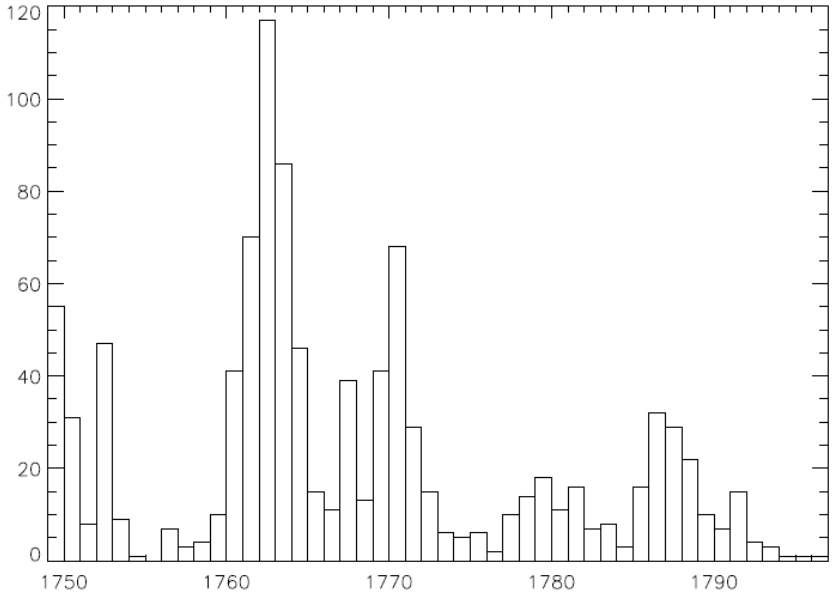
Vaquero et al. (2011), ApJ

3.2. Drawings by Staudacher (Rainer Arlt)

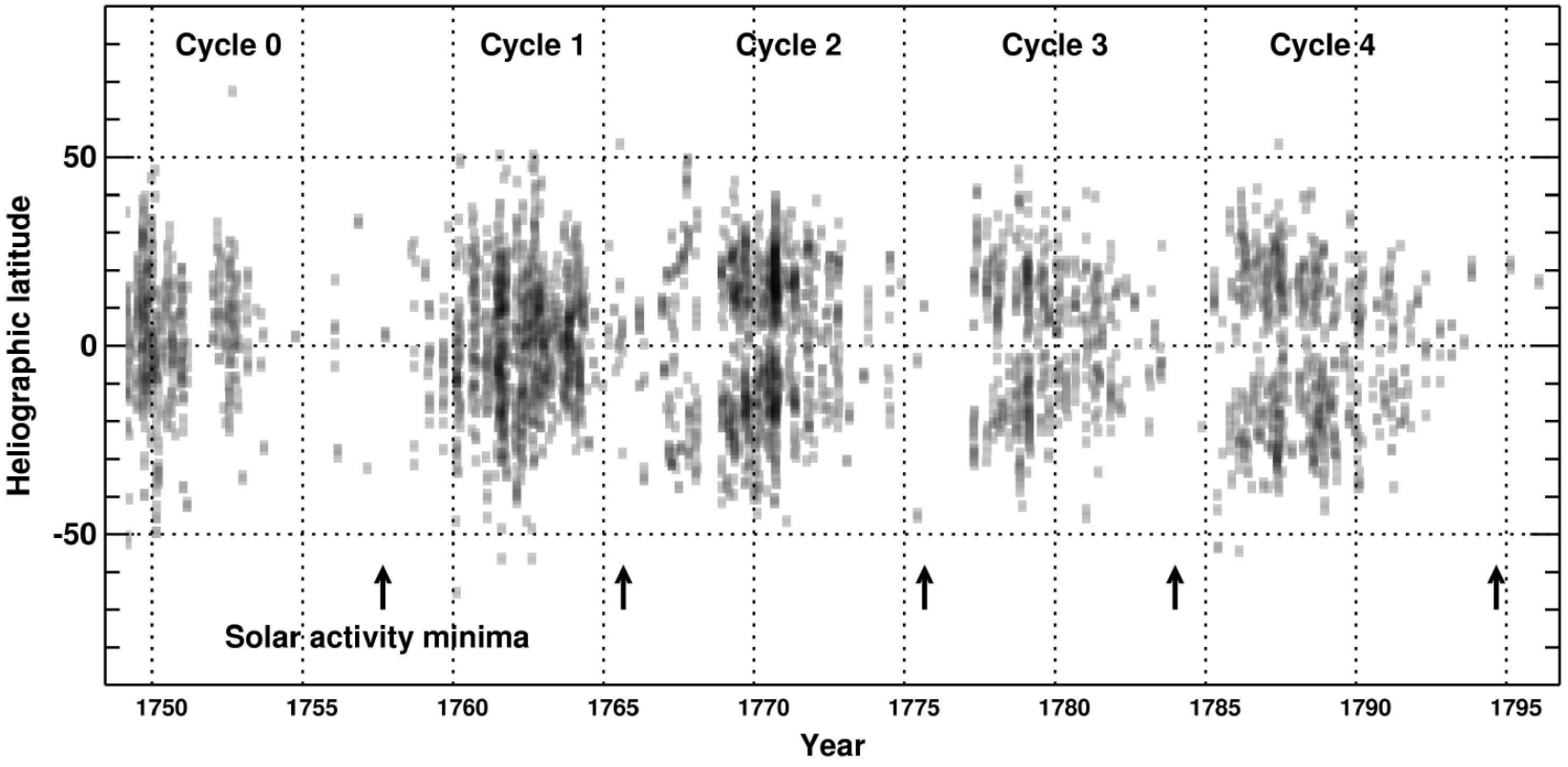
R. Arlt (2008) “Digitization of Sunspot Drawings by Staudacher in 1749 – 1796” *Solar Physics* 247, 399-410.



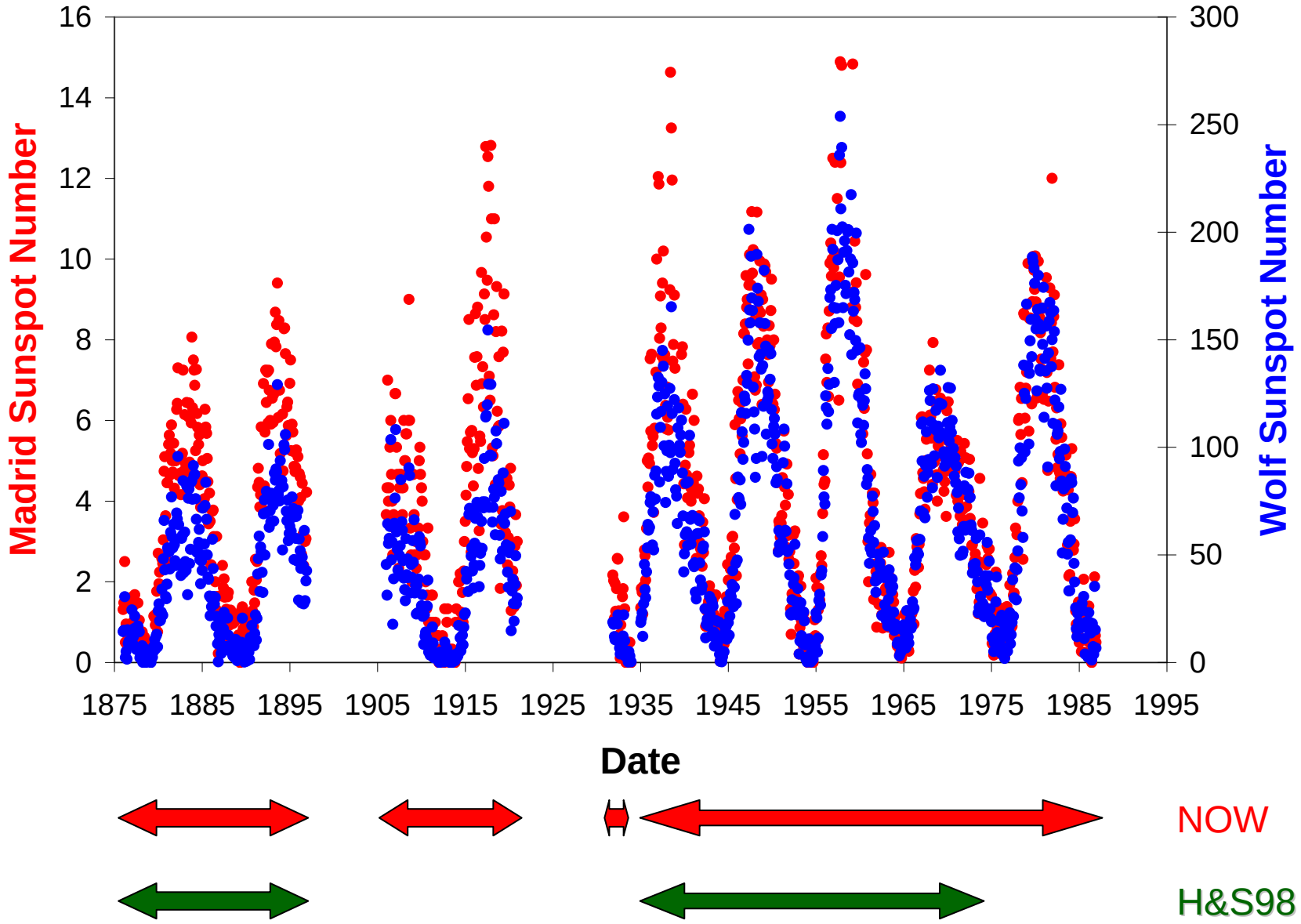
R. Arlt (2008) digitized original drawings by J.C. Staudacher made in the period of 1749 – 1796. Arlt also evaluated the usefulness of the drawings for the determination of sunspot positions for future studies.

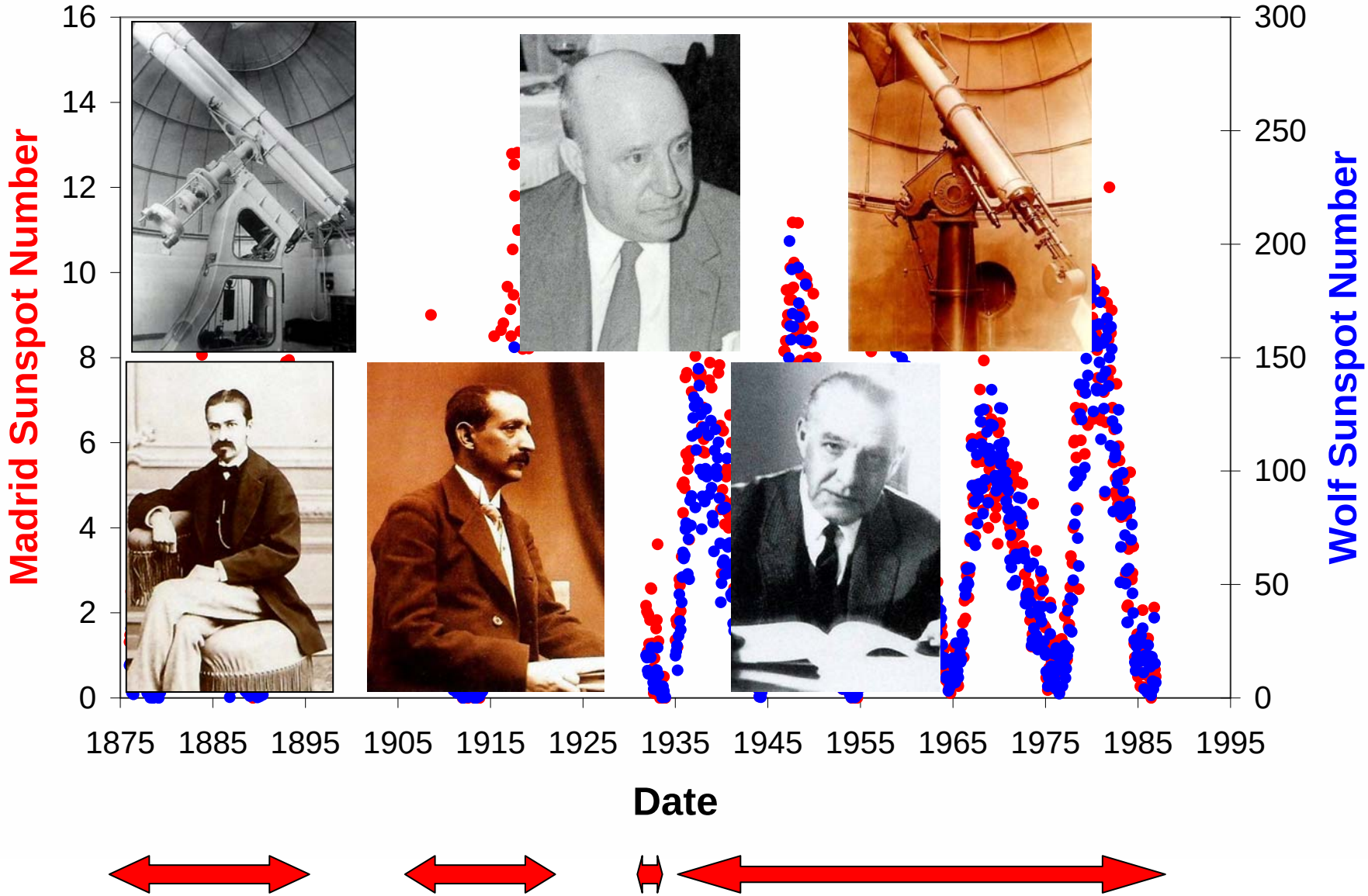


R. Arlt (2009) “The Butterfly Diagram in the Eighteenth Century” *Solar Physics* **255**(1), 143-153, DOI: 10.1007/s11207-008-9306-5

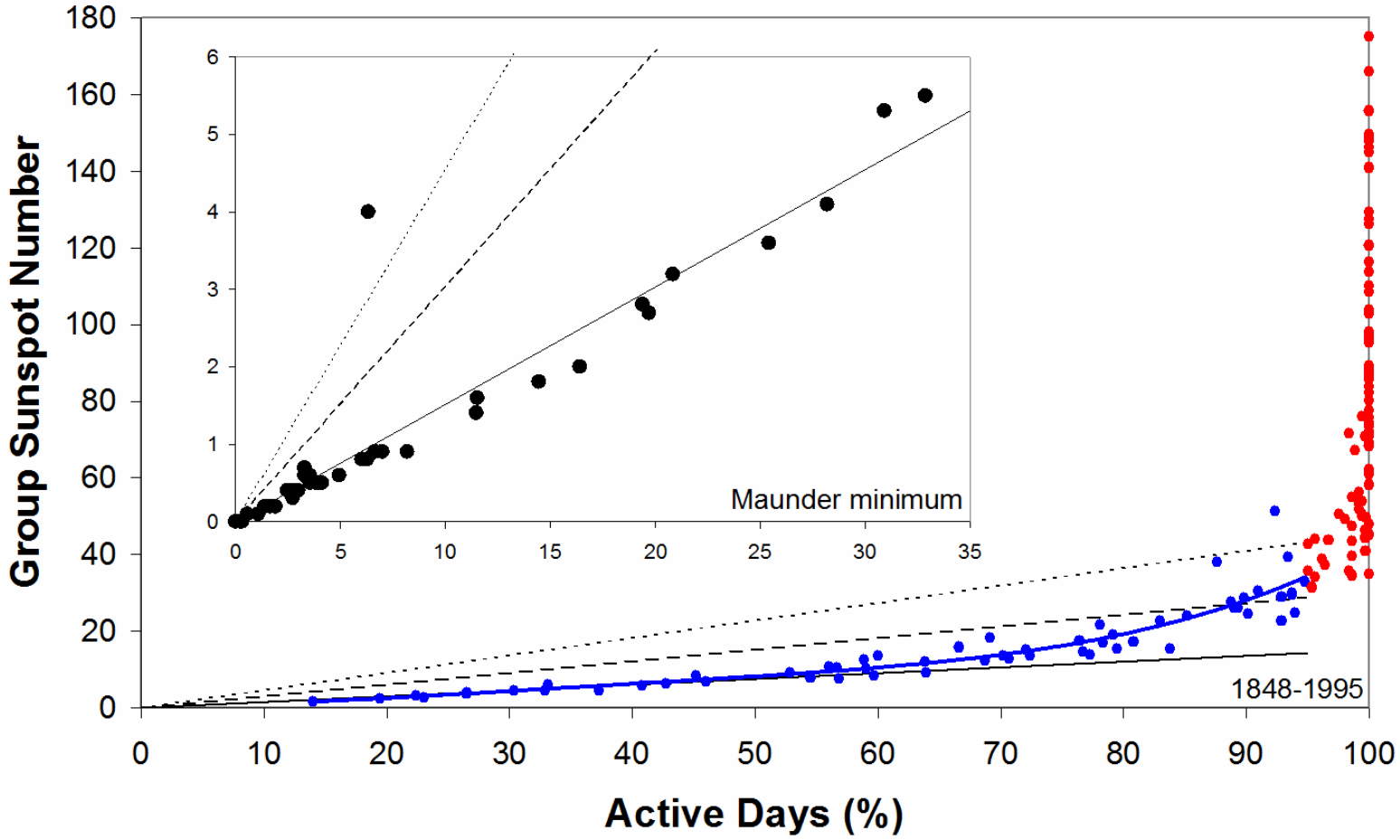


3.3. Madrid SSN: 110 years of solar observations

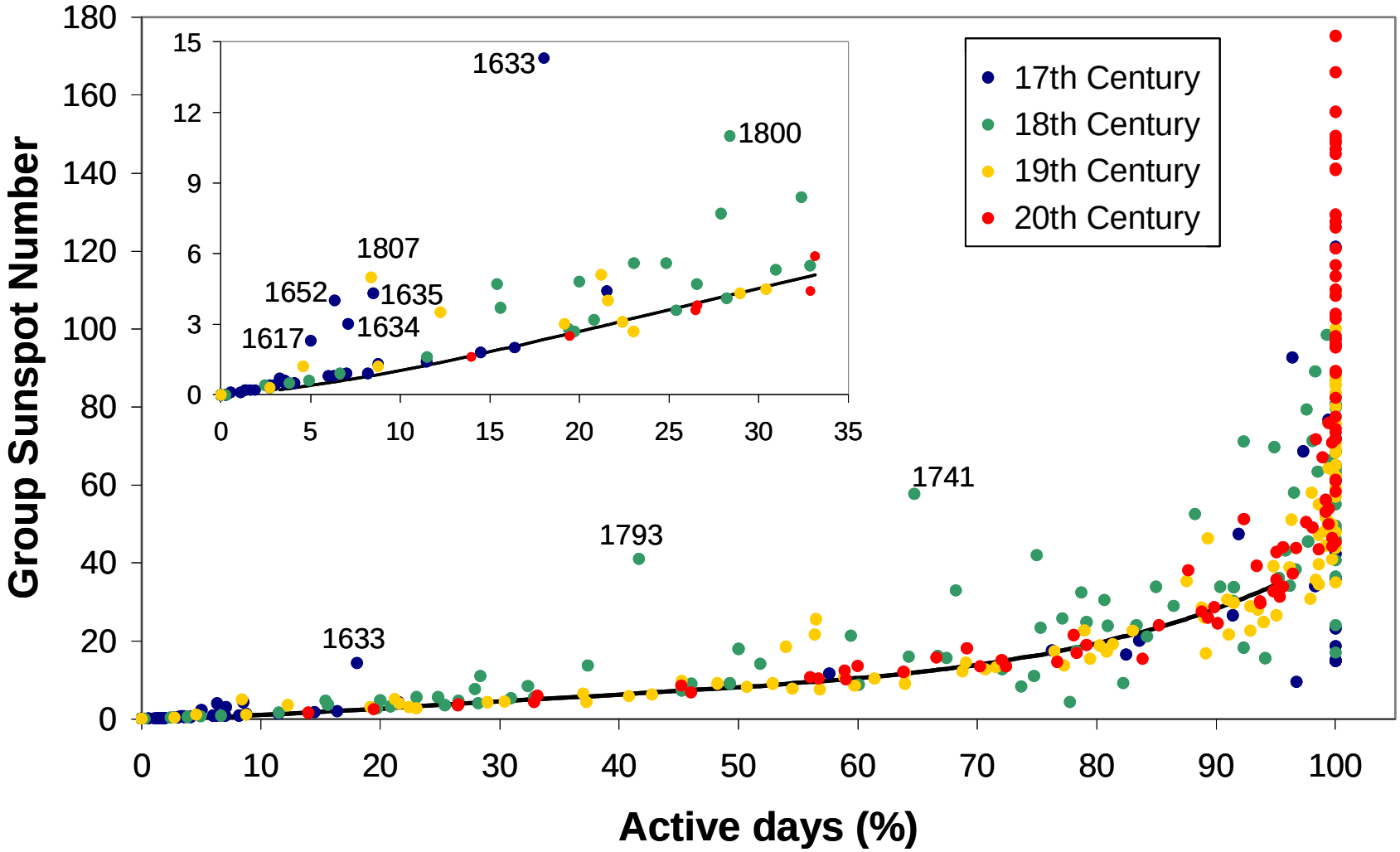



Madrid Sunspot Number
Wolf Sunspot Number
Date
0
2
4
6
8
10
12
14
16
0
50
100
150
200
250
300
1875
1885
1895
1905
1915
1925
1935
1945
1955
1965
1975
1985
1995

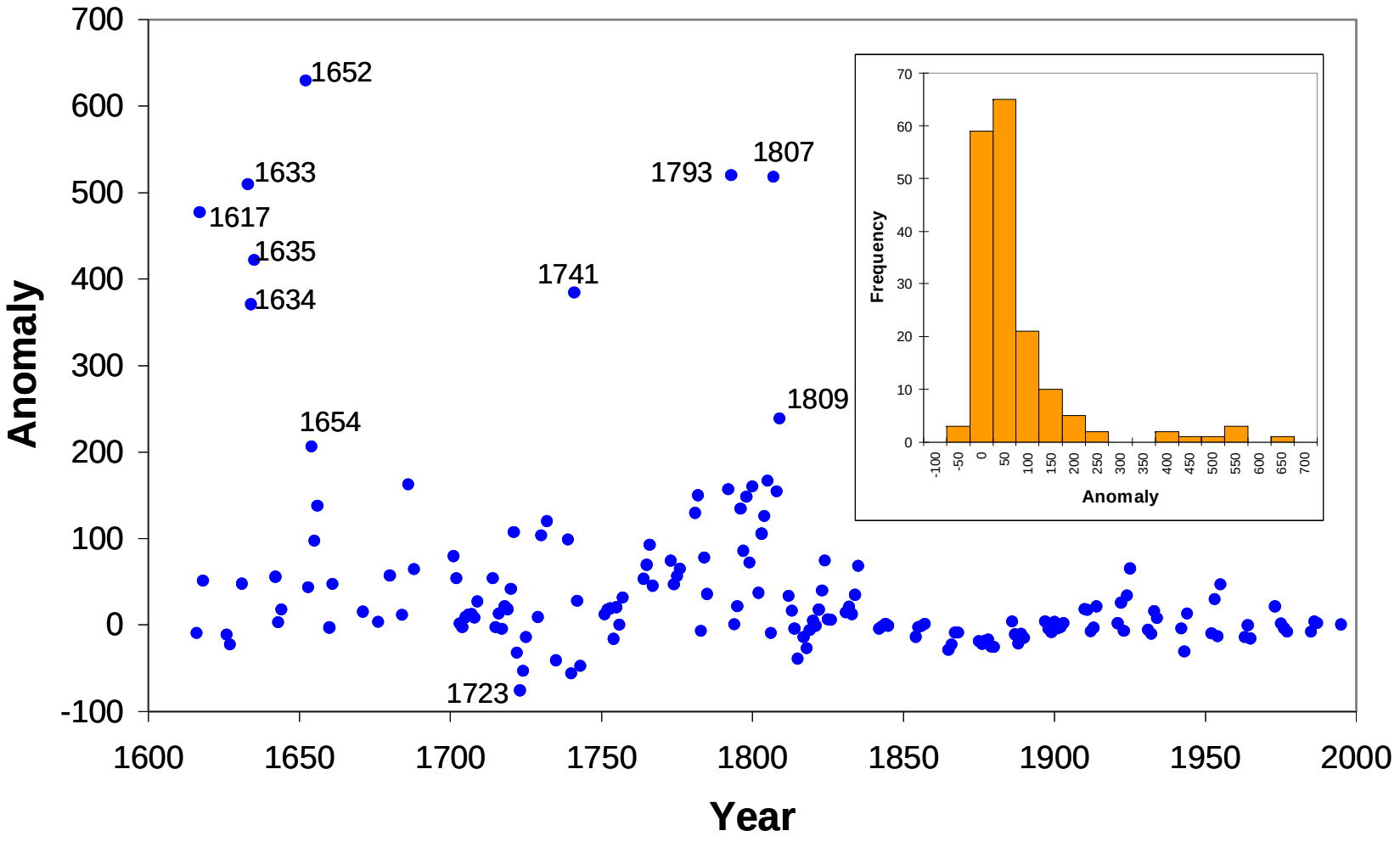
4. Quality Control: an example



Relationship between GSN and AD for 1848-1995 from Hoyt and Schatten (1998). Polynomial fit (order 4) is showed for AD<95% (blue line and points). Graphic inserted shows the same relationship during the Maunder minimum. Black lines represent the theoretical values for an average observer with 1 (continuous), 2 (dashed), and 3 (dotted) groups for each active day.



Relationship between GSN and AD for all available data from HS98. Black line is the polynomial fit of Figure 1. The inset presents an enlarged version but restricted to values AD<35%

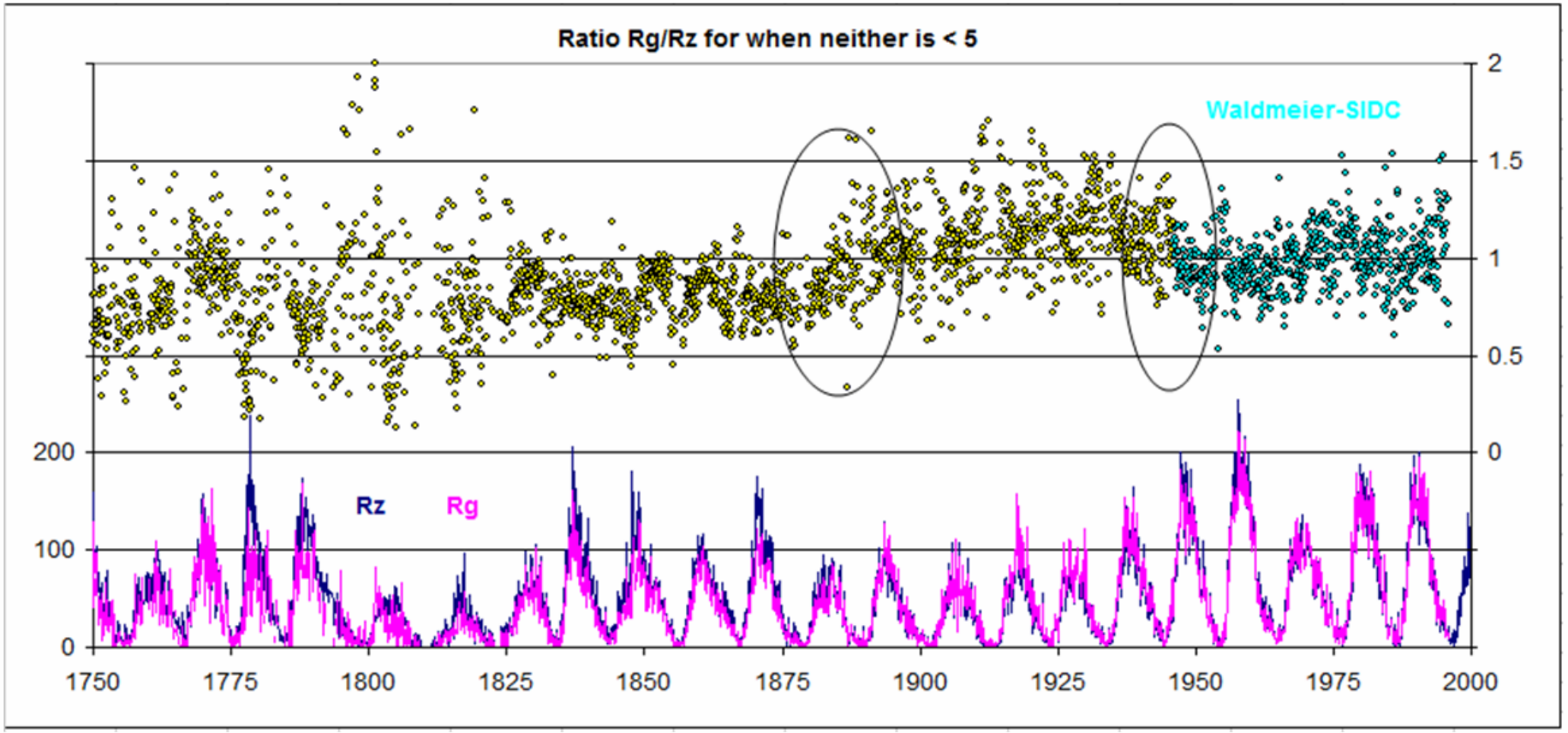


Anomaly values for GSN (blue dots). Graphic inserted shows the distribution of these values.

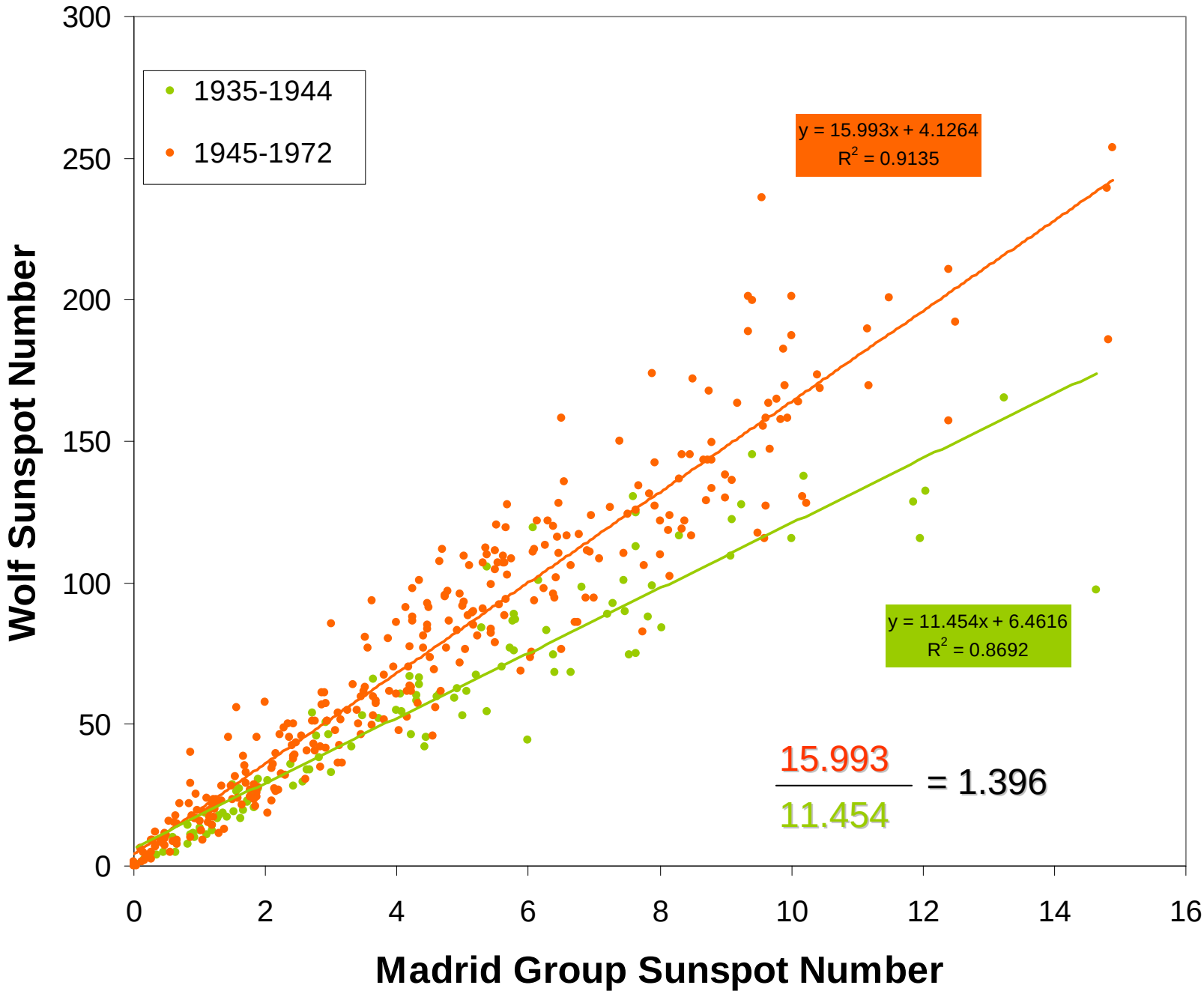
5. Leif's breakpoints

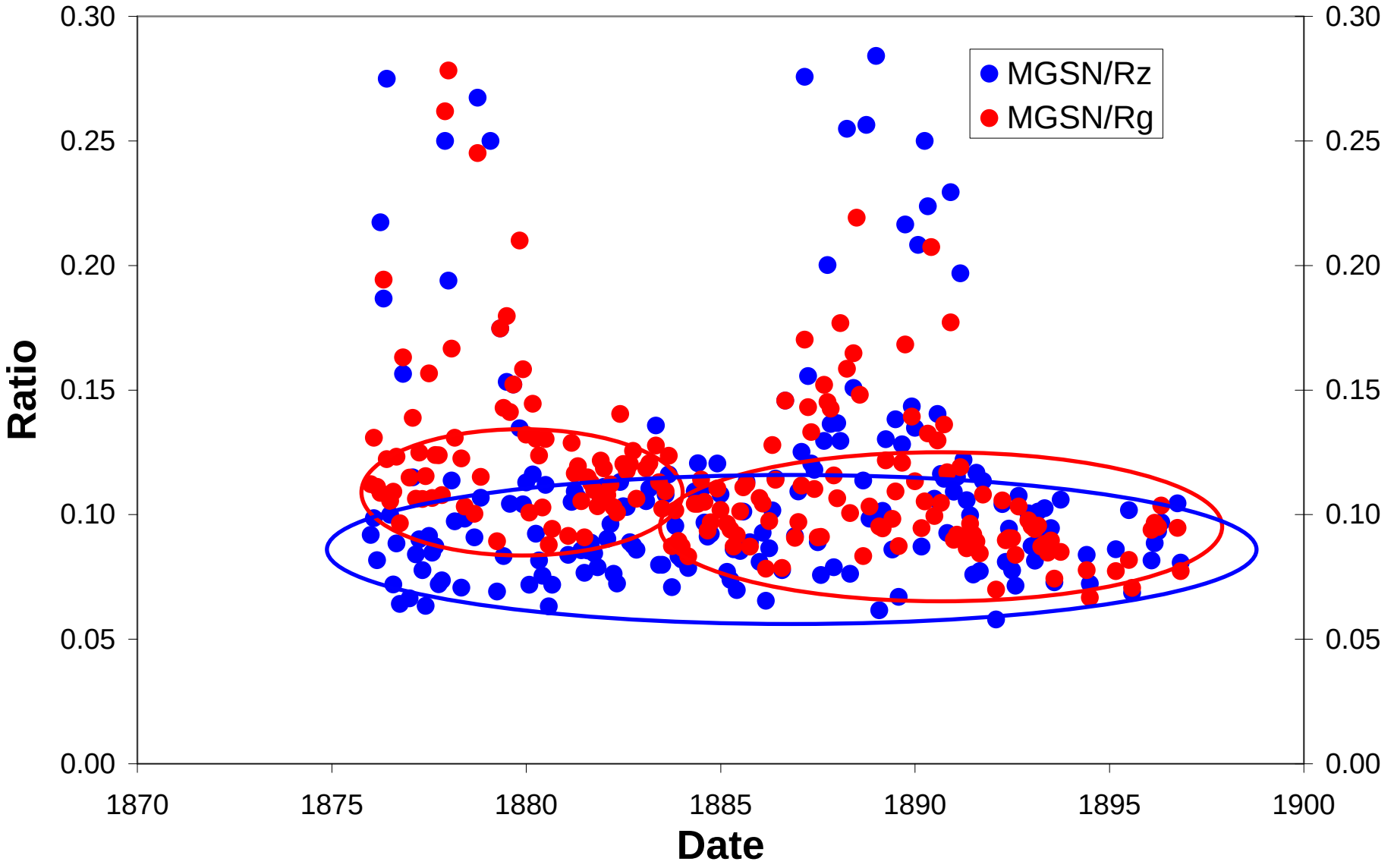
Cliver, Svalgaard & Schatten (2011)
IUGG XXV General Assembly, IAGA Symposium A12.2

The Ratio Group/Zurich SSN has Two Significant Discontinuities



At ~1946 (After Max Waldmeier took over) and at ~1885

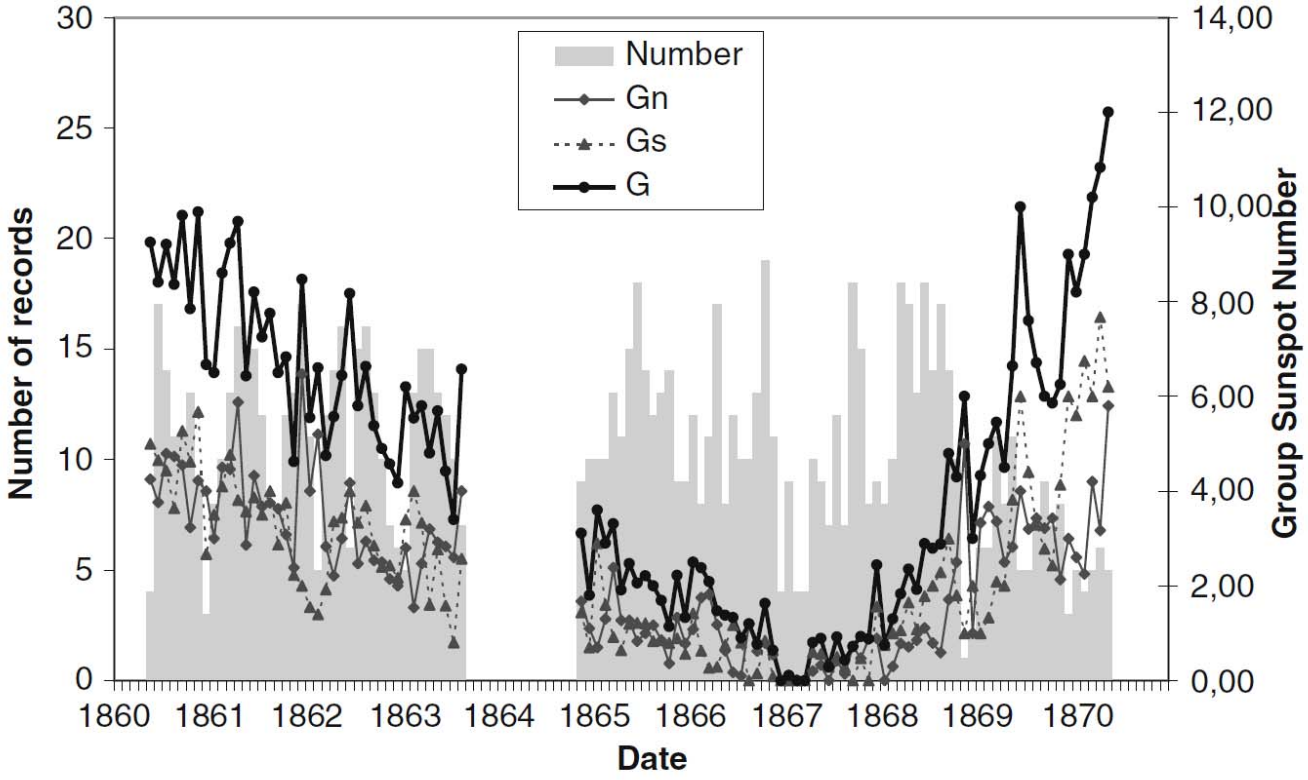

300
250
200
150
100
50
0
0
2
4
6
8
10
12
14
16
Wolf Sunspot Number
Madrid Group Sunspot Number
1935-1944
1945-1972
y = 15.993x + 4.1264
R2 = 0.9135
y = 11.454x + 6.4616
R2 = 0.8692
15.993
11.454
= 1.396

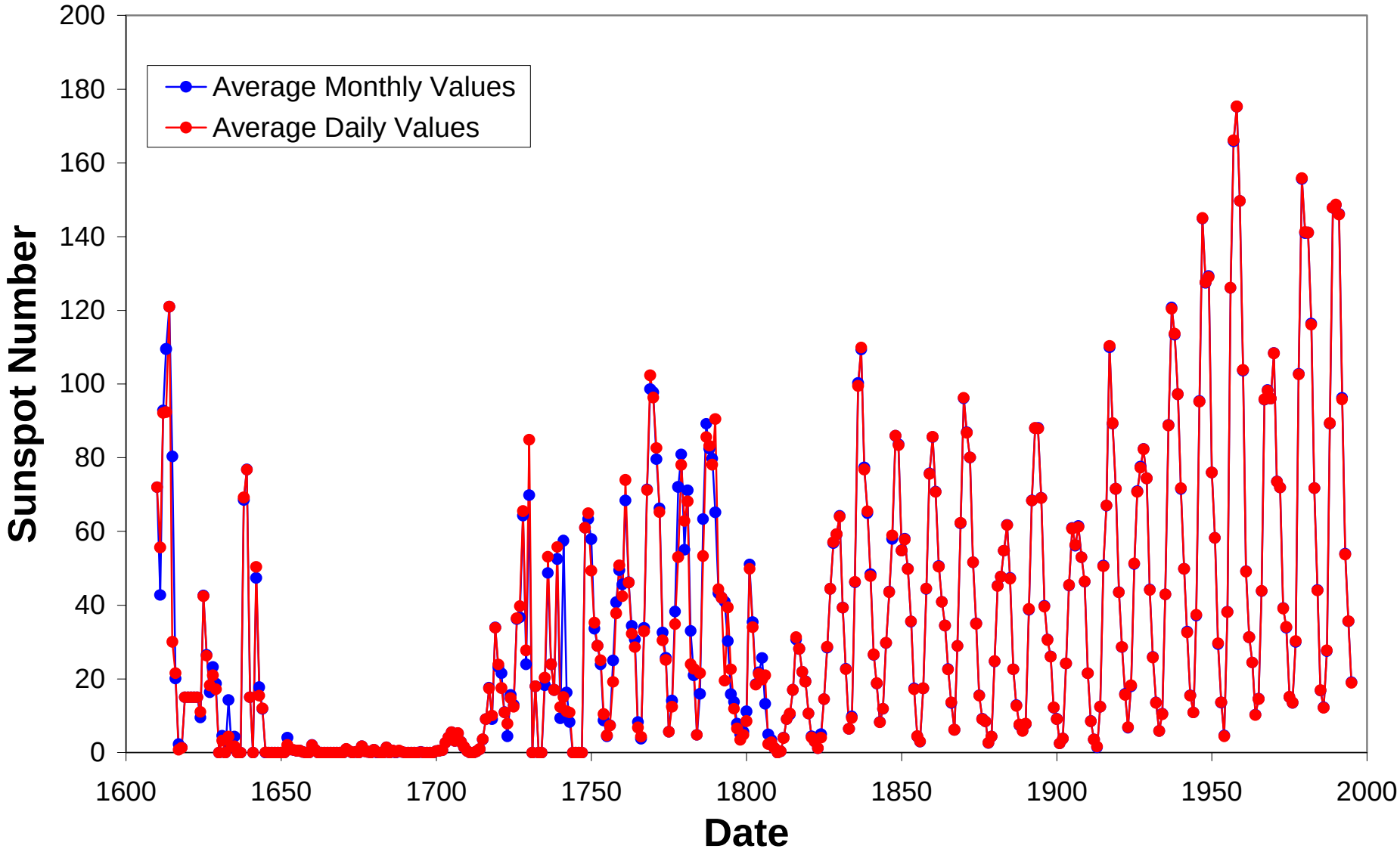

MGSN/Rz
MGSN/Rg
Ratio
Date
0.30
0.25
0.20
0.15
0.10
0.05
0.00
1870
1875
1880
1885
1890
1895
1900

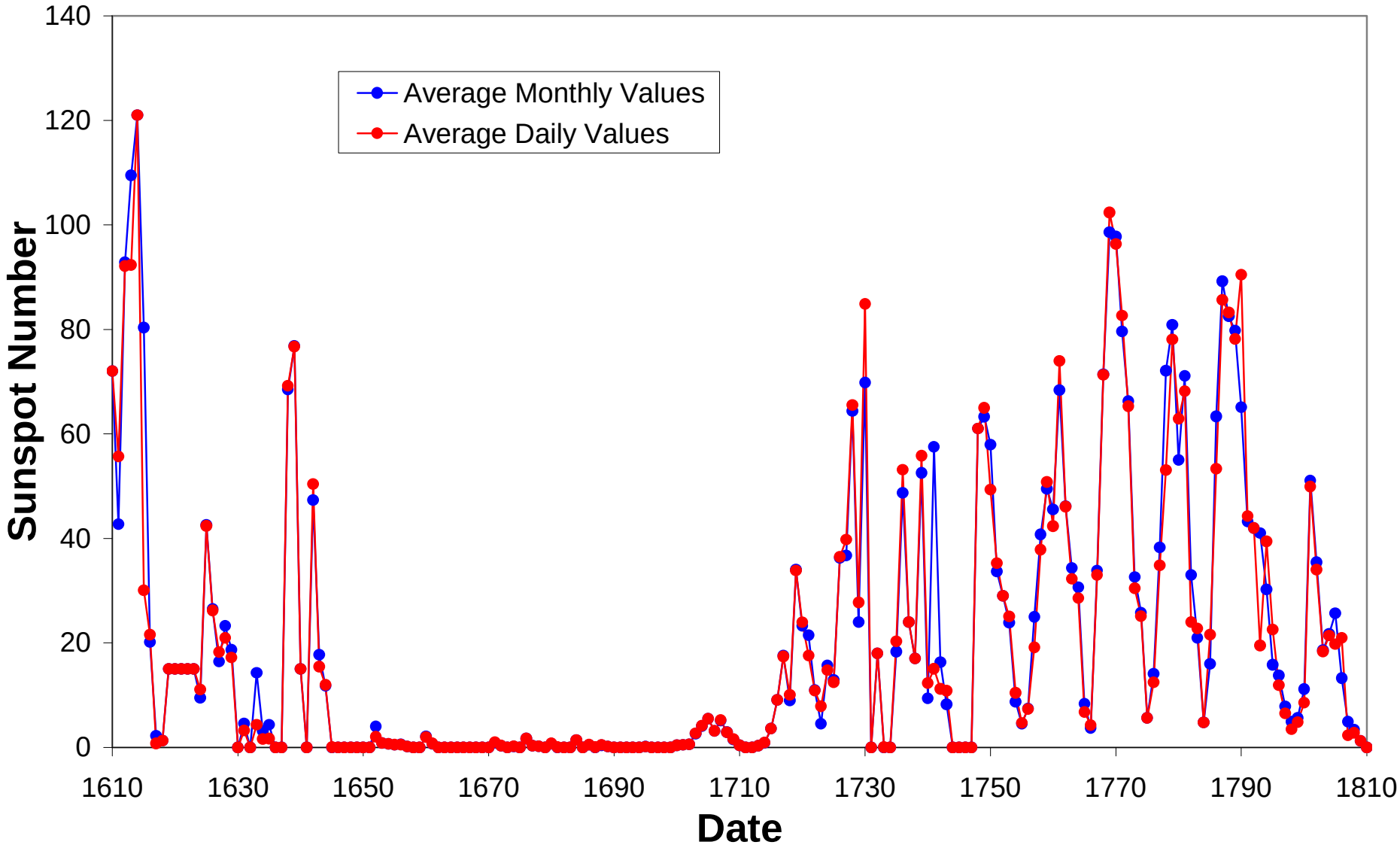
6. Some additional proposals

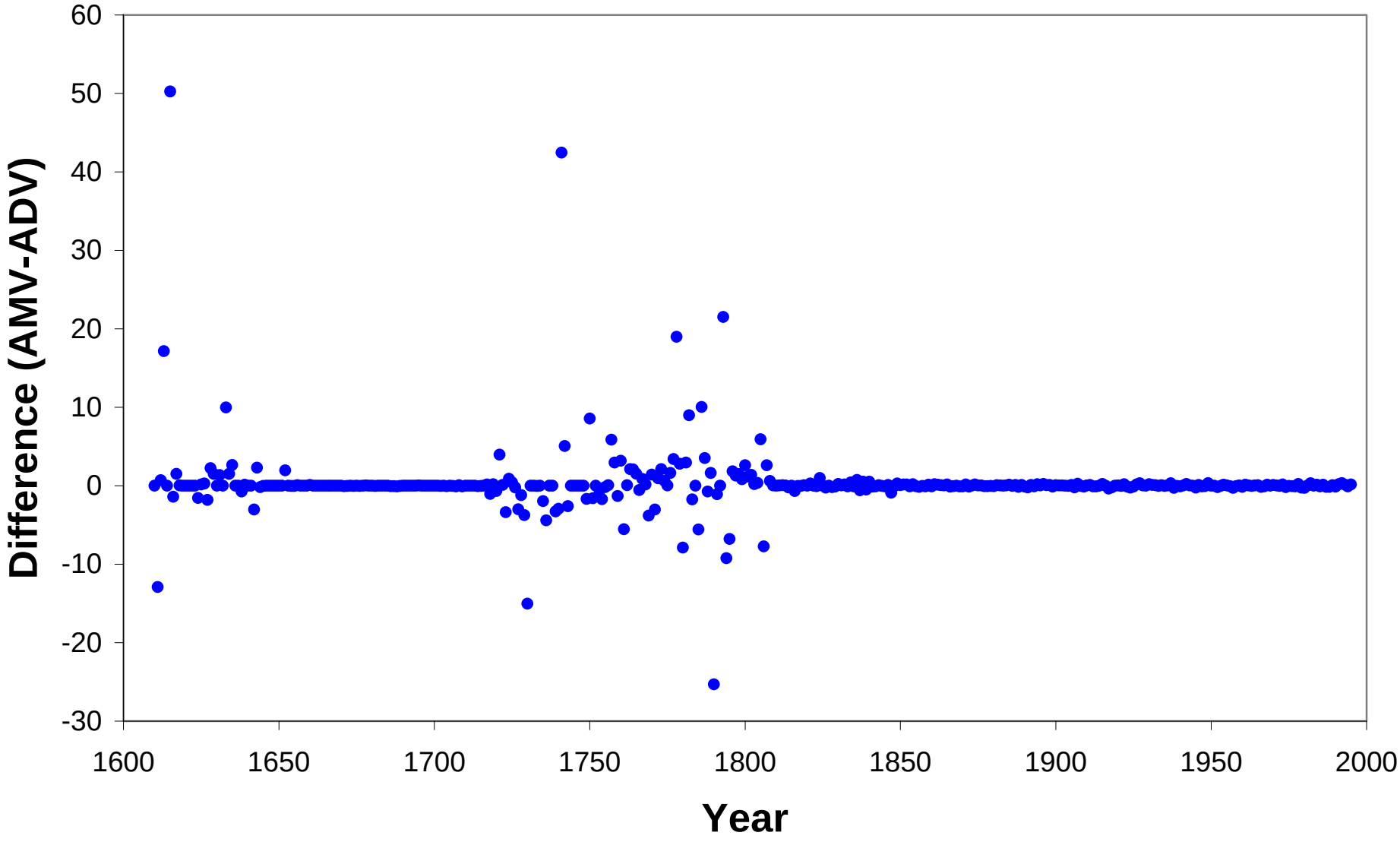
✓We need a archive or library which preserve all the historical material related with sunspots records (originals [old books, journals or manuscripts], paper copies, photocopies, digital copies, etc.).

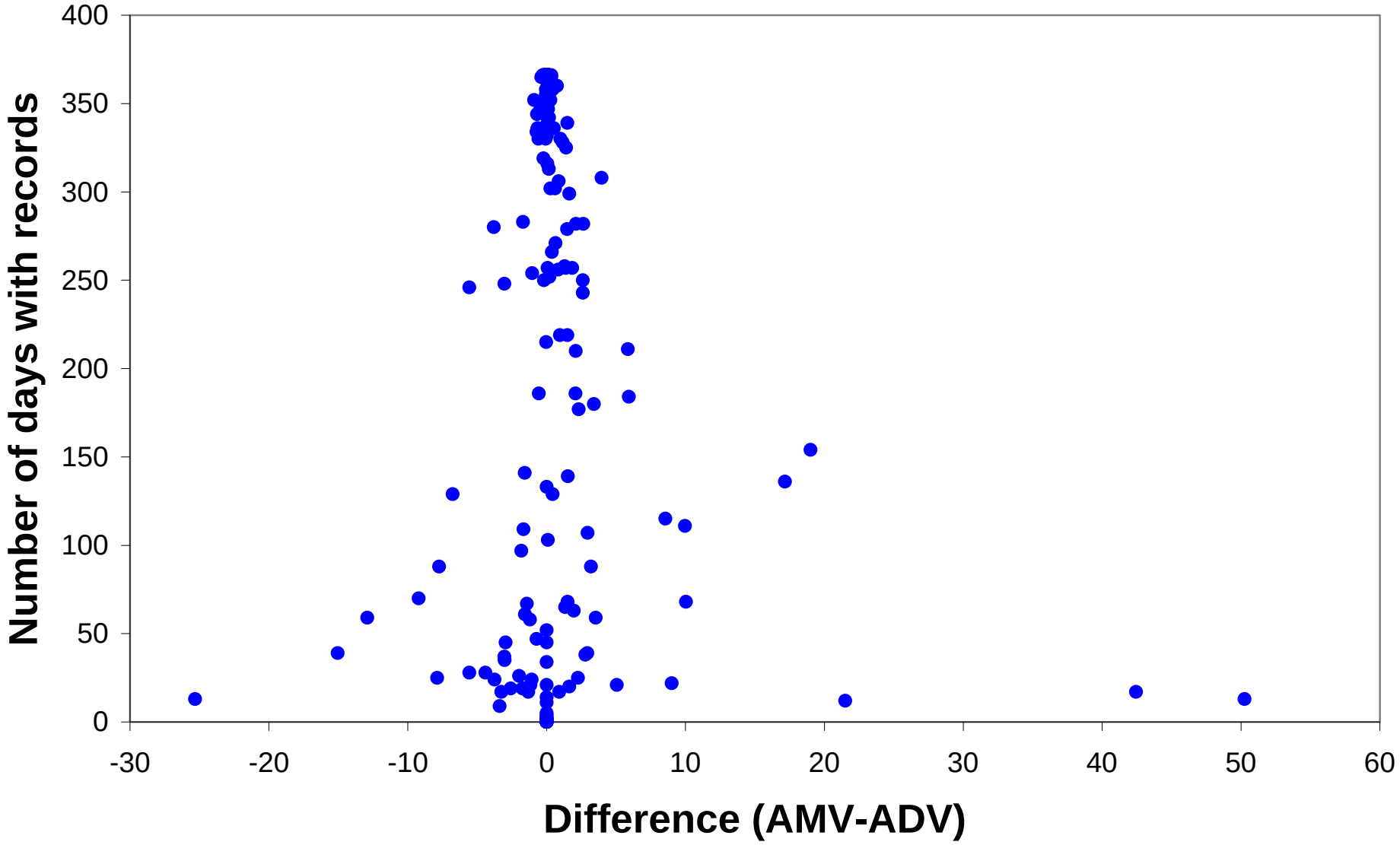
✓I think that it is possible to construct a hemispheric sunspot number using old sunspot drawings prior to RGO epoch (Staudacher, Schwabe, Peters, de la Rue, Carrington, etc..).




Average Monthly Values
Average Daily Values
Sunspot Number
Date
200
180
160
140
120
100
80
60
40
20
0
1600
1650
1700
1750
1800
1850
1900
1950
2000


Average Monthly Values
Average Daily Values
Sunspot Number
Date
0
20
40
60
80
100
120
140
1610
1630
1650
1670
1690
1710
1730
1750
1770
1790
1810


Difference (AMV-ADV)
60
50
40
30
20
10
0
-10
-20
-30
1600
1650
1700
1750
1800
1850
1900
1950
2000
Year


Number of days with records
400
350
300
250
200
150
100
50
0
-30
-20
-10
0
10
20
30
40
50
60
Difference (AMV-ADV)