Solar Bulletin

THE AMERICAN ASSOCIATION OF VARIABLE STAR OBSERVERS
SOLAR SECTION

Rodney Howe, Kristine Larsen, Co-Chairs
c/o AAVSO, 185 Alewife Brook Parkway,
Cambridge, MA 02138 USA

Web: https://www.aavso.org/solar-bulletin
Email: solar@aavso.org
ISSN 0271-8480

Volume 80 Number 1 January 2024

The Solar Bulletin of the AAVSO is a summary of each month's solar activity recorded by visual solar observers' counts of group and sunspots, and the VLF radio recordings of SID Events in the ionosphere. The sudden ionospheric disturbance report is in Section 2. The relative sunspot numbers are in Section 3. Section 4 has endnotes.

1 Solar Activity: Dispelling Misconceptions

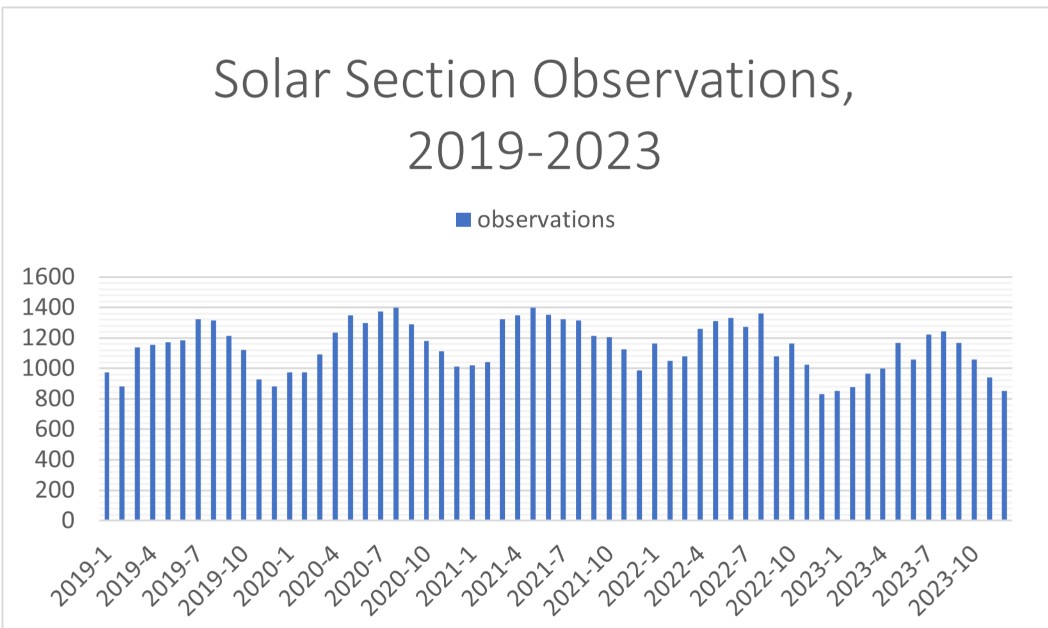

Figure 1: Here are 5 years of seasonal variations in the total number of observations per month.

We continue to observe the sun because our daily observations will aid solar scientists in further improving their models and lead to enhanced prediction methods in the future. Of course, our ability to observe the sun depends on the weather, which we all know is also difficult to predict with certainty. We should therefore always be honest about the limits of our scientific understanding and careful when interpreting statistical data, as shown in Figures 1 and 2.

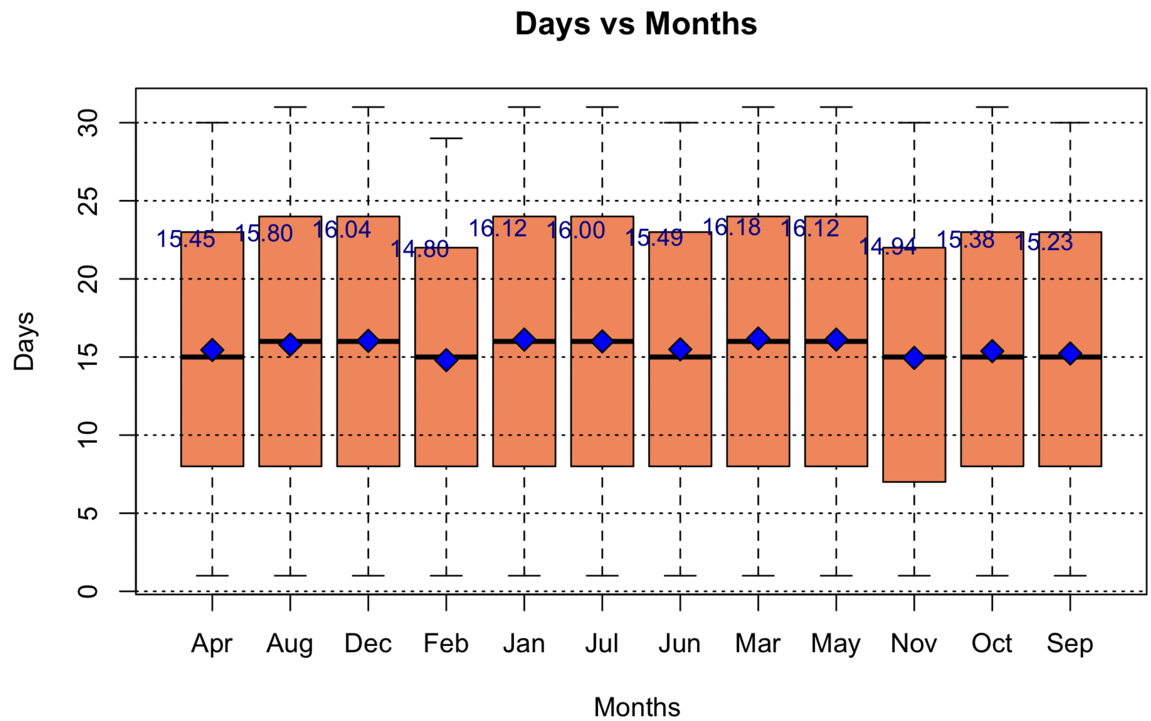

Figure 2: Across the 5 years of data it looks like Feb and Nov have the lowest average days of monthly observations, of course Feb has fewer days. Different views of data have different consequences!

Here's a timely counter example - in a recent commercial produced by the payroll and HR solutions company ADP, a massive solar flare adds an extra hour to the day (leading to chaos in calculating overtime). While humorous, the commercial plays to widespread public misconceptions concerning solar activity, including presumed connections with other natural disasters (such as earthquakes and volcanic outbursts). As solar activity follows its normal ramp-up toward solar maximum, we expect to see more interest in the sun in the media (generally a positive effect), as well as the predictable increase in misconceptions concerning solar activity, including sunspots, flares, and coronal mass ejections (the inevitable drawback). There will probably also be an increase in sensational and alarmist blogposts, YouTube videos, and social media posts warning of another Carrington event (or an even more powerful, including claims that a superflare will fry the planet). This is where the members of the Solar Section can make a difference (beyond submitting your valuable observations to the AAVSO Solar database, even in the dead of winter). Take a moment to educate yourself on the common misconceptions concerning our star and its normal periodic activity; when the opportunity arises please dispel fears and misconceptions and/or proactively share correct information with the general public. You might recruit a new solar observer.

ADP commercial: `https://www.youtube.com/watch?v=5mi3x3EL2Vo`

NASA Solar Flare FAQ: `https://blogs.nasa.gov/solarcycle25/2022/06/10/solar-flares-faqs/`

National Weather Service Space Weather and Safety: `https://www.weather.gov/safety/space`

US Geological Survey: Do Solar Flares Cause Earthquakes?:
`https://www.usgs.gov/faqs/do-solar-flares-or-magnetic-storms-space-weather-cause-earthquakes`

2 Sudden Ionospheric Disturbance (SID) Report

2.1 SID Records

January 2024 (Figure 3): One of the most active days recorded here in Fort Collins, Colorado was on the 23rd of January with 15 C-class and 8 M-Class flare events.

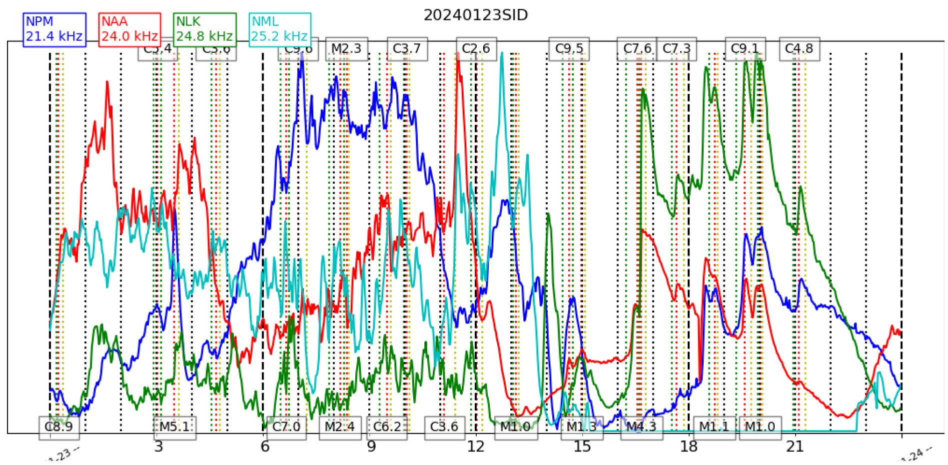

Figure 3: VLF recording from Fort Collins, CO.

2.2 SID Observers

In January 2024 we had 16 AAVSO SID observers who submitted VLF data, as listed in Table 1.

Table 1: 202401 VLF Observers

Observer	Code	Stations
R Battaiola	A96	HWU
J Wallace	A97	NAA
A Son	A112	DHO
L Loudet	A118	DHO GQD
J Godet	A119	GBZ GQD ICV
F Adamson	A122	NWC
J Karlovsky	A131	TBB
R Mrllak	A136	GQD NSY
S Aguirre	A138	NAA
G Silvis	A141	NAA NML NPM
K Menzies	A146	NAA
L Pina	A148	NAA NLK
J Wendler	A150	NAA
H Krumnow	A152	DHO FTA GBZ
J DeVries	A153	NLK
M Salo	A157	NLK

Figure 4 depicts the importance rating of the solar events. The duration in minutes are -1: LT 19, 1: 19-25, 1+: 26-32, 2: 33-45, 2+: 46-85, 3: 86-125, and 3+: GT 125.

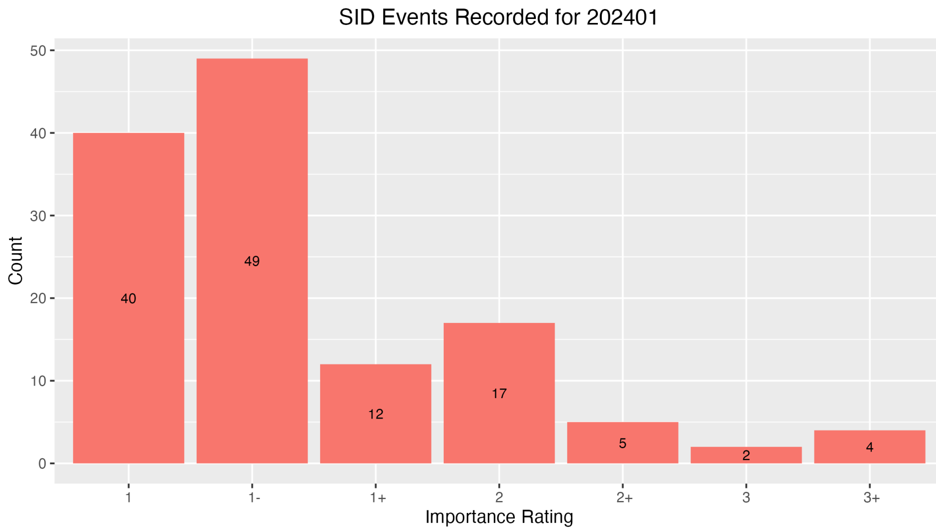

Figure 4: VLF SID Events.

2.3 Solar Flare Summary from GOES-16 Data

In January 2024, there were 321 GOES-16 XRA flares: 30 M-Class, 287 C-Class, and 4 B Class. More flaring this month compared to last.. (U.S. Dept. of Commerce–NOAA, 2022; see Figure 5).

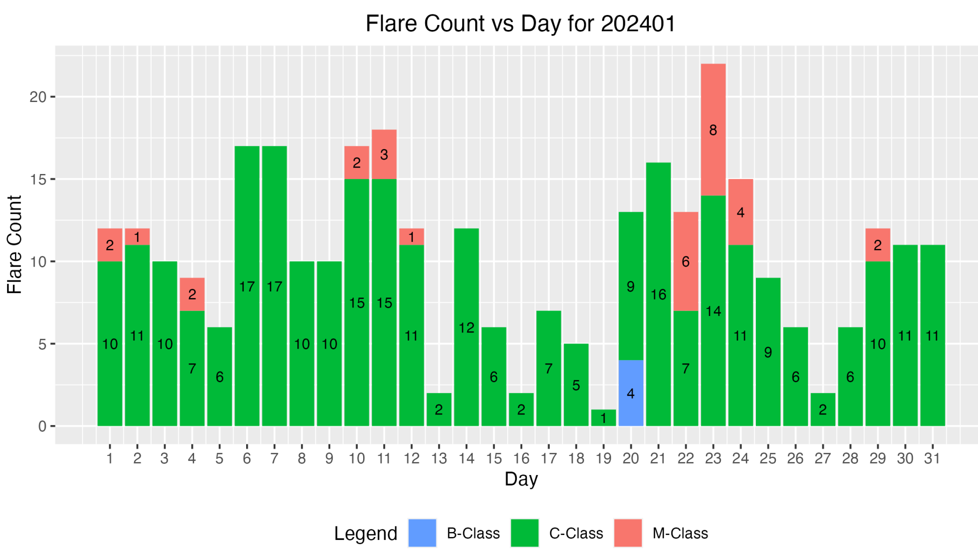

Figure 5: GOES-16 XRA flares (U.S. Dept. of Commerce–NOAA, 2022).

3 Relative Sunspot Numbers (R_a)

Reporting monthly sunspot numbers consists of submitting an individual observer's daily counts for a specific month to the AAVSO Solar Section. These data are maintained in a Structured Query Language (SQL) database. The monthly data then are extracted for analysis. This section is the portion of the analysis concerned with both the raw and daily average counts for a particular month. Scrubbing and filtering assure error-free data are used to determine the monthly sunspot numbers.

3.1 Raw Sunspot Counts

The raw daily sunspot counts consist of submitted counts from all observers who provided data in January 2024. These counts are reported by the day of the month. The reported raw daily average counts have been checked for errors and inconsistencies, and no known errors are present. All observers whose submissions qualify through this month's scrubbing process are represented in Figure 6.

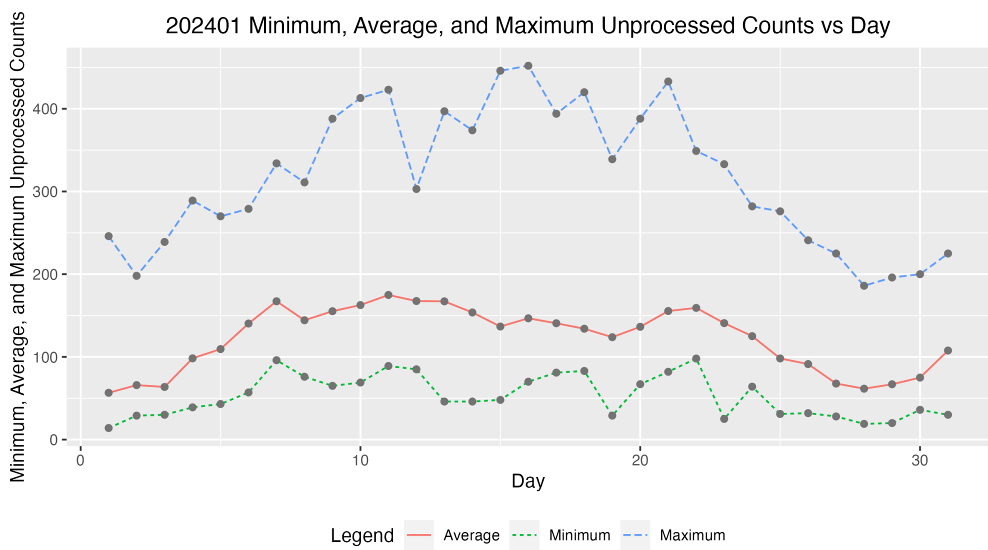

Figure 6: Raw Wolf number average, minimum and maximum by day of the month for all observers.

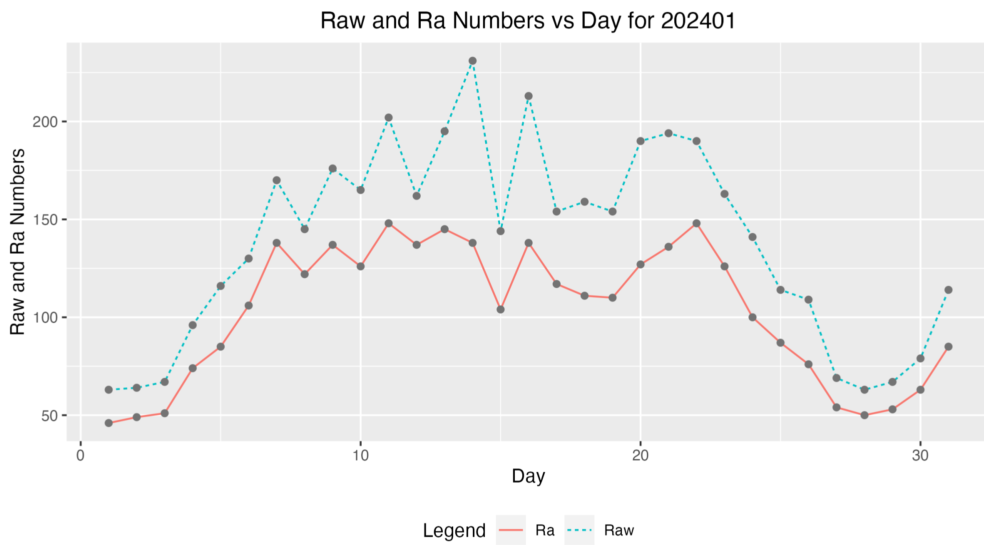

Figure 7: Raw Wolf average and R_a numbers by day of the month for all observers.

3.2 American Relative Sunspot Numbers

The relative sunspot numbers, R_a, contain the sunspot numbers after the submitted data are scrubbed and modeled by Shapley's method with k-factors (`http://iopscience.iop.org/article/10.1086/126109/pdf`). Wolf averages and calculated R_a are seen in Figure 7, and Table 2 shows the Day of the observation (column 1), the Number of Observers recording that day (column 2), the raw Wolf number (column 3), and the Shapley Correction (R_a) (column 4).

Table 2: 202401 American Relative Sunspot Numbers (R_a).

Day	Number of Observers	Raw	R_a
1	31	63	46
2	24	64	49
3	20	67	51
4	26	96	74
5	24	116	85
6	18	130	106
7	22	170	138
8	23	145	122
9	24	176	137
10	22	165	126
11	24	202	148
12	22	162	137
13	23	195	145
14	18	231	138
15	21	144	104
16	21	213	138
17	21	154	117

Continued

Table 2: 202401 American Relative Sunspot Numbers (R_a).

Day	Number of Observers	Raw	R_a
18	19	159	111
19	24	154	110
20	31	190	127
21	25	194	136
22	24	190	148
23	23	163	126
24	23	141	100
25	24	114	87
26	22	109	76
27	27	69	54
28	32	63	50
29	28	67	53
30	26	79	63
31	23	114	85
Averages	23.7	138.7	102.8

3.3 Sunspot Observers

Table 3 lists the Observer Code (column 1), the Number of Observations (column 2) submitted for January 2024, and the Observer Name (column 3). The final row gives the total number of observers who submitted sunspot counts (67), and total number of observations submitted (812).

Table 3: 202401 Number of observations by observer.

Observer Code	Number of Observations	Observer Name
AJV	9	J. Alonso
ARAG	30	Gema Araujo
ASA	3	Salvador Aguirre
AXX	16	Alexandre Amorim
BATR	3	Roberto Battaiola
BKL	2	John A. Blackwell
BMF	16	Michael Boschat
BMIG	18	Michel Besson
BXZ	13	Jose Alberto Berdejo
BZX	10	A. Gonzalo Vargas
CKB	20	Brian Cudnik
CLDB	11	Laurent Cambon
CMAB	6	Maurizio Cervoni
CNT	28	Dean Chantiles
CPAD	4	Panagiotis Chatzistamatiou
CVJ	2	Jose Carvajal

Continued

Table 3: 202401 Number of observations by observer.

Observer Code	Number of Observations	Observer Name
DARB	21	Aritra Das
DELS	1	Susan Delaney
DGIA	14	Giuseppe di Tommasco
DJOB	12	Jorge del Rosario
DJSA	3	Jeff DeVries
DJVA	21	Jacques van Delft
DMIB	18	Michel Deconinck
DUBF	18	Franky Dubois
EGMA	1	Georgios Epitropou
EHOA	17	Howard Eskildsen
ERB	2	Bob Eramia
FERA	3	Eric Fabrigat
FLET	19	Tom Fleming
GIGA	25	Igor Grageda Mendez
GJLB	9	Josep Maria Llenas Garcia
HALB	11	Brian Halls
HKY	10	Kim Hay
HOWR	17	Rodney Howe
HSR	14	Serge Hoste
IEWA	16	Ernest W. Iverson
ILUB	7	Luigi Iapichino
JGE	5	Gerardo Jimenez Lopez
JSI	2	Simon Jenner
KAND	15	Kandilli Observatory
KNJS	31	James & Shirley Knight
KTOC	13	Tom Karnuta
LKR	6	Kristine Larsen
LRRA	3	Robert Little
LVY	26	David Levy
MARE	17	Enrico Mariani
MARC	5	Arnaud Mengus
MCE	25	Etsuiku Mochizuki
MJHA	28	John McCammon
MLL	2	Jay Miller
MMI	31	Michael Moeller
MWU	19	Walter Maluf
NMID	4	Melina Niemczyk
RARD	10	Arnav Ranjekar
RJV	13	Javier Ruiz Fernandez
RMW	2	Michael Rapp
SDOH	31	Solar Dynamics Obs - HMI
SNE	2	Neil Simmons
SQN	18	Lance Shaw

Continued

Table 3: 202401 Number of observations by observer.

Observer Code	Number of Observations	Observer Name
SRIE	12	Rick St. Hilaire
TDE	17	David Teske
TNIA	2	Nick Tonkin
TPJB	2	Patrick Thibault
TST	9	Steven Toothman
URBP	6	Piotr Urbanski
VIDD	12	Dan Vidican
WGI	3	Guido Wollenhaupt
WWM	7	William M. Wilson
Totals	812	67

3.4 Generalized Linear Model of Sunspot Numbers

Dr. Jamie Riggs, Solar System Science Section Head, International Astrostatistics Association, maintains a relative sunspot number (R_a) model containing the sunspot numbers after the submitted data are scrubbed and modeled by a Generalized Linear Mixed Model (GLMM), which is a different model method from the Shapley method of calculating R_a in Section 3 above. The GLMM is a statistical model that accounts for variation due to random effects and fixed effects. For the GLMM R_a model, random effects include the AAVSO observer, as these observers are a selection from all possible observers, and the fixed effects include seeing conditions at one of four possible levels. More details on GLMM are available in the paper, *A Generalized Linear Mixed Model for Enumerated Sunspots* (see 'GLMM06' in the sunspot counts research page at http://www.spesi.org/?page_id=65).

Figure 8 shows the monthly GLMM R_a numbers for a rolling eleven-year (132-month) window beginning within the 24th solar cycle and ending with last month's sunspot numbers. The solid cyan curve that connects the red *X's* is the GLMM model R_a estimates of excellent seeing conditions, which in part explains why these R_a estimates often are higher than the Shapley R_a values. The dotted black curves on either side of the cyan curve depict a 99% confidence band about the GLMM estimates. The green dotted curve connecting the green triangles is the Shapley method R_a numbers. The dashed blue curve connecting the blue *O's* is the SILSO values for the monthly sunspot numbers.

The tan box plots for each month are the actual observations submitted by the AAVSO observers. The heavy solid lines approximately midway in the boxes represent the count medians. The box plot represents the InterQuartile Range (IQR), which depicts from the 25^{th} through the 75^{th} quartiles. The lower and upper whiskers extend 1.5 times the IQR below the 25^{th} quartile, and 1.5 times the IQR above the 75^{th} quartile. The black dots below and above the whiskers traditionally are considered outliers, but with GLMM modeling, they are observations that are accounted for by the GLMM model.

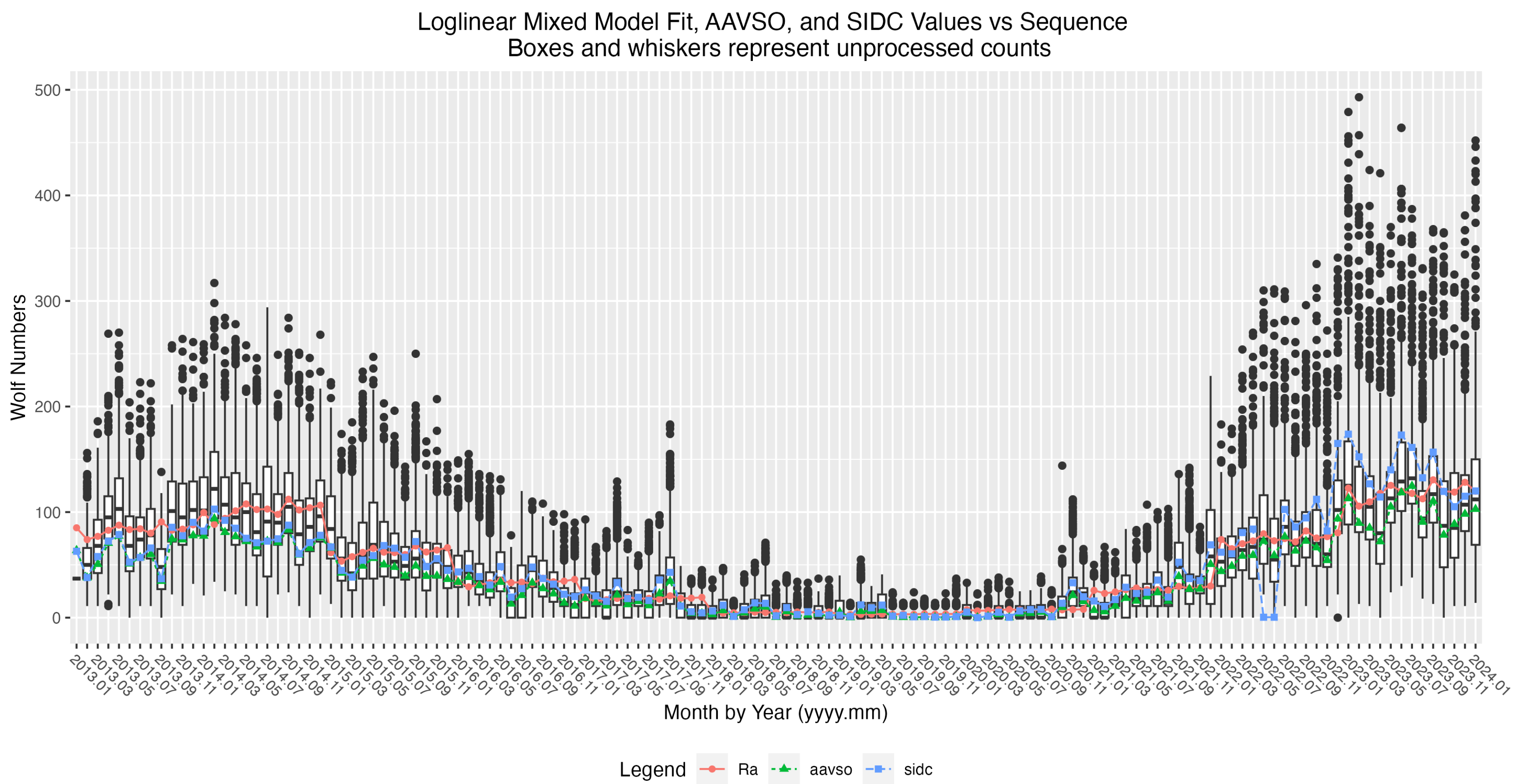

Figure 8: GLMM fitted data for R_a. AAVSO data: https://www.aavso.org/category/tags/solar-bulletin. SIDC data: WDC-SILSO, Royal Observatory of Belgium, Brussels.

4 Endnotes

- Sunspot Reports: Kim Hay solar@aavso.org
- SID Solar Flare Reports: Rodney Howe rhowe137@icloud.com

5 Year end comparison of AAVSO and SILSO numbers

Compartive Summary 2023 of Raw, Ra and Rint

GLOBAL DATA SUNSPOTS FOR 2023 BY MONTH											
MONTH	NUMBER OF DAYS	OBSERVERS AAVSO SOLAR SECTION						OBSERVERS INTERNATIONAL GROUP			
		TOTAL OBS	Mean / Day	Raw	Mean / Day	Ra	Mean / Day	TOTAL OBS	Mean / Day	Rint	Mean / Day
1	31	854	27,5	4380	141,3	3500	112,9	855	27,6	4475	144,4
2	28	876	31,3	3469	123,9	2510	89,6	1014	36,2	3116	111,3
3	31	965	31,1	3641	117,5	2636	85,0	1081	34,9	3823	123,3
4	30	1001	33,4	2857	95,2	2163	72,1	1132	37,7	2927	97,6
5	31	1169	37,7	3827	123,5	3254	105,0	1240	40,0	4260	137,4
6	30	1054	35,1	4333	144,4	3556	118,5	1248	41,6	4815	160,5
7	31	1205	38,9	4472	144,3	3866	124,7	1039	33,5	4932	159,1
8	31	1242	40,1	3345	107,9	2810	90,6	1095	35,3	3560	114,8
9	30	1167	38,9	4077	135,9	3313	110,4	1140	38,0	4009	133,6
10	31	1040	33,5	3160	101,9	2431	78,4	958	30,9	3081	99,4
11	30	940	31,3	3315	110,5	2657	88,6	809	27,0	3162	105,4
12	31	853	27,5	3861	124,5	3043	98,2	619	20,0	3541	114,2
Total 2023	**365**	***12366***	***33,9***	***44737***	***122,6***	***35739***	***97,9***	***12230***	***33,5***	***45701***	***125,2***
Mean		**1030,5**	**33,9**	**3728,1**	**122,6**	**2978,3**	**97,9**	**1019,2**	**33,5**	**3808,4**	**125,2**
Standard Deviation		**139,3**	**4,3**	**519,4**	**16,6**	**523,8**	**16,5**	**184,3**	**6,2**	**694,2**	**21,8**

Important Notes : For a given month, the same observer can be counted as many times as there are days in the month.

Sources : For Ra and Raw, Solar Bulletin, AAVSO Solar Section. [https://www.aavso.org/solar-bulletin]
For Rint, SILSO Web site, Daily total sunspot number (1/1/1818 - now). [https://www.sidc.be/silso/INFO/sndtotcsv.php]

Figure 9: This graph is from Max Surlaroute (MMAY). "As usual, at the start of the year, I am sending you, for information purposes, the summary of the overall data and statistics from the previous year (2023)."

6 Antique telescope project

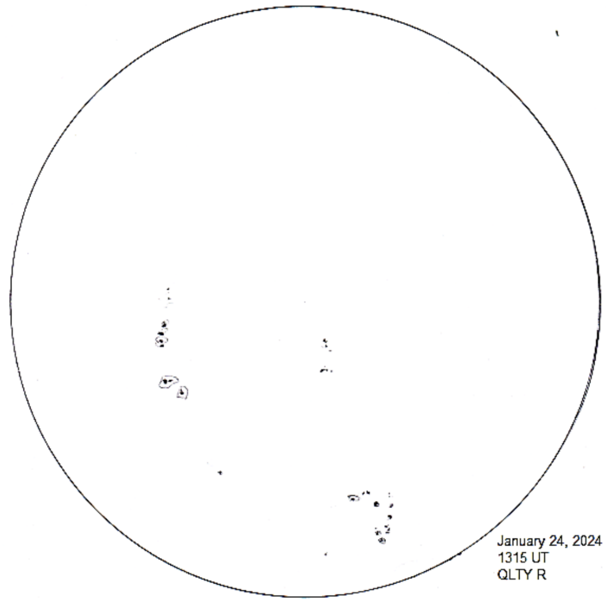

Figure 10: The day after the 22 XRA flares (Figure 3) it's not easy to show where all those flares came from in this drawing by Gonzalo Vargas (BZX).

7 References

(MMAY) For Ra and Raw, Solar Bulletin, AAVSO Solar Section.
`https://www.aavso.org/solar-bulletin`

(MMAY) For Rint, SILSO Web site, Daily total sunspot number (1/1/1818 - now).
`https://www.sidc.be/silso/INFO/sndtotcsv.php`

U.S. Dept. of Commerce–NOAA, Space Weather Prediction Center. (2023).
GOES-16 XRA data `ftp://ftp.swpc.noaa.gov/pub/indices/events/`