

Solar Bulletin

THE AMERICAN ASSOCIATION OF VARIABLE STAR OBSERVERS
SOLAR SECTION



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Preface

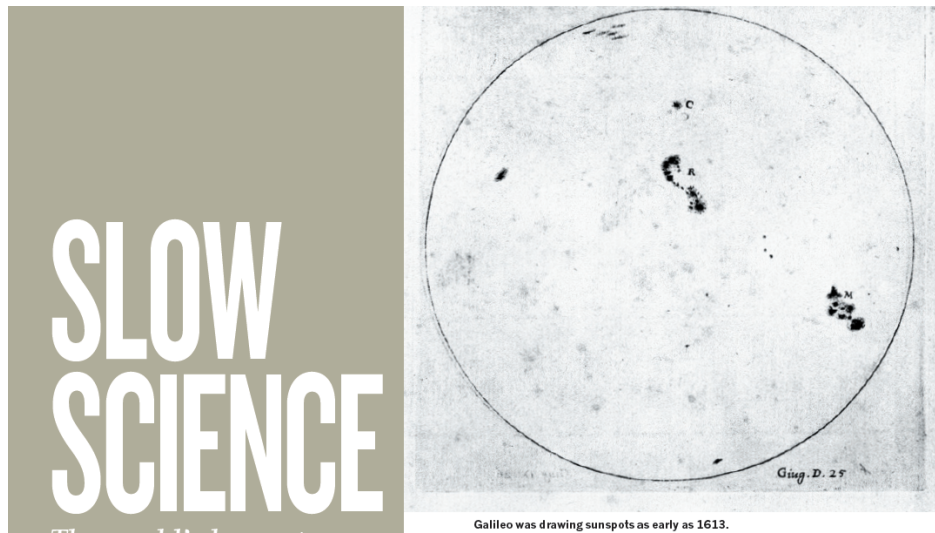
The *Solar Bulletin* of the American Association of Variable Star Observers (ISSN 0271-8480) is the publication of record for observational data relating to sunspot and sudden ionospheric disturbance (SID) observations by Solar Section observers of the AAVSO. The *Solar Bulletin* is published monthly in the calendar month following the cover date (i.e. the January issue is published in mid-February, and contains data for January). It has been published regularly with few interruptions since 1944.

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Note that data from the AAVSO Solar Section are only available either via the *Bulletin* or via NOAA's National Geophysical Data Center. We are working toward making these data available electronically via the AAVSO website in the very near future.

1 AAVSO Long time solar observations is a Slow Science



Galileo was drawing sunspots as early as 1613.

Figure 1: Sunspot data goes back to Gallileo (1610), (Arlt, R., Vaquero, Jose M., 2020). AAVSO data goes back to 1924.



Figure 2: Two long time observers are Herbert Luft and Thomas Cragg. Far left is Casper Hossfield. (Solar Chair) (Svalgaard, (2017)



Figure 3: The slow science of long time observers: here is Etsuiku Mochizuki (MCE) who submitted over 50 years (1961- 2016) of observations.

SOLAR ECLIPSE - APRIL 1969

AAVSO - SOLAR DIVISION

AMERICAN SUNSPOT NUMBER OBSERVATIONS

MONTHLY MEAN $R_A' = 178.2$ JULY 1958 MONTHLY MEAN $R_Z = 197.7$

OBSERVER	K1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
Adams	Arbe	8.9	16.79	13.00						17.12	16.40				11.16	14.72	14.73	14.69															
Bundy	1	8.9	16.68	10.81						15.16	16.00				10.36	10.30			14.53														
von Braun	Bucksatz	1	8.88	6.38						14.45	9.88	8.85	7.57	6.47					15.87		15.81												
Cragg	32	8.74	11.92	10.02	13.14	14.11	10.10	9.13	10.11	10.25	8.13	8.1	5.97	10.31	8.48	8.46			10.53	10.72	12.51	14.27	13.71	12.81		9.55	9.46			11.53	14.65	16.7	
DeKinde	10	10.66	9.51	9.57						10.63	6.71			9.33	2.88				8.65	9.66	6.33	10.32	12.76	9.95		9.71	6.89						
Ellas	17.3	12.70	11.40	11.02	13.24	14.17	12.11	13.15	10.24	9.55	10.05	9.10	8.66	15.51	9.31	10.60	12.73	12.91	10.94	15.91	8.89	17.51				12.47							
Estremadoyro	1	11.73	10.71							16.77					9.44				9.46		10.75												
Fisher	1	10.2		12.44	12.76	15.74									17.00	15.74	10.57	8.42	10.88	8.25													
Hicks	1														5.21			8.19	9.24	10.42	9.86				11.30	8.47		8.44					
Teabashi	1														9.57	10.47			9.78														
Loehle	1														8.31	8.37																	
Hof	4.8	11.50	14.39	11.11	11.28					13.22					10.83					13.62	14.49	17.05					15.08						
Loehle	1														8.31	8.37																	
Noon	2.8														10.31																		
Nicolini	1														8.24	8.40																	
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Ratne																																	

Figure 4: A early spreadsheet of solar observers from July 1958.



Figure 5: Here we are looking at the sun.

Young observers may continue to observe if given the opportunity. The rationale will be to use Slow Science to create solar cycle light curves of calculated sunspot counts over the long term. Light curves like the ones we put in all our monthly solar bulletins for raw and Ra index come from all our current solar submitters; see below in section 3. (Arlt, R., Vaquero, Jose M. [2020]).

Arlt, R., Vaquero, Jose M. (2020) Historical sunspot records. Sunspot observations are available in fairly good

numbers since 1610. https://www.researchgate.net/publication/339511111_Historical_sunspot_records

Svalgaard, (2017), Sunspot Group Numbers Since 1900 and Implications for the Long-term Record of Solar Activity. https://www.researchgate.net/publication/316736457_Sunspot_Group_Numbers_Since_1900_and_Implications_for_the_Long-term_Record_of_Solar_Activity

2 Sudden Ionospheric Disturbance (SID) Report

2.1 SID Records

July 2026 (Figure 6): July 4th was the most active day this month: one X class, 13 M class and 6 C class flares. SID graph from Lionel Laudet in Southern France. (U.S. Dept. of Commerce–NOAA, 2022).

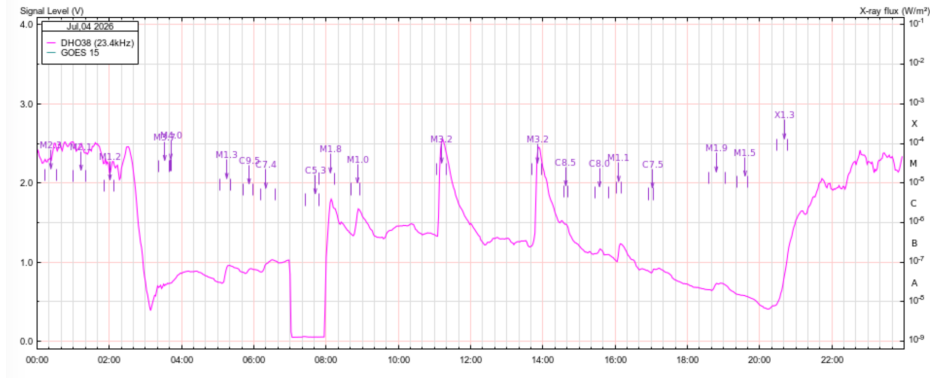


Figure 6 Sudden Ionospheric Disturbance (SID) Report

2.2 SID Observer

In July 2026 we had 7 AAVSO SID observers who submitted VLF data as listed in Table 1.

Table 1: 202607 VLF Observers

Observer	Code	Stations
R Battaiola	A96	ICV
L Loudet	A118	DHO GBZ
J Godet	A119	DHO GBZ GQD
L Pina	A148	NAA NML NLK
J Wendler	A150	NAA
J DeVries	A153	NLK
M Cervoni	A154	DHO

2.3 SID Events

Figure 7 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.

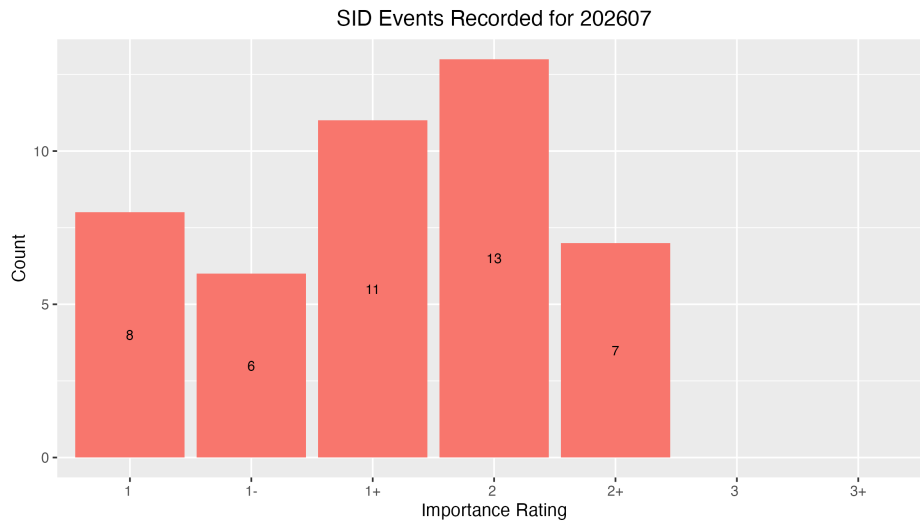


Figure 7 depicts the importance rating of the solar events.

2.4 Solar Flare Summary from GOES-16 Data

In July 2026, there were 236 GOES-19 XRA flares: one X-class, 56 M-class, 159 C-class, and 20 B-class. Far less flaring this month compared to last month. (U.S. Dept. of Commerce–NOAA, 2022). (see Figure 8

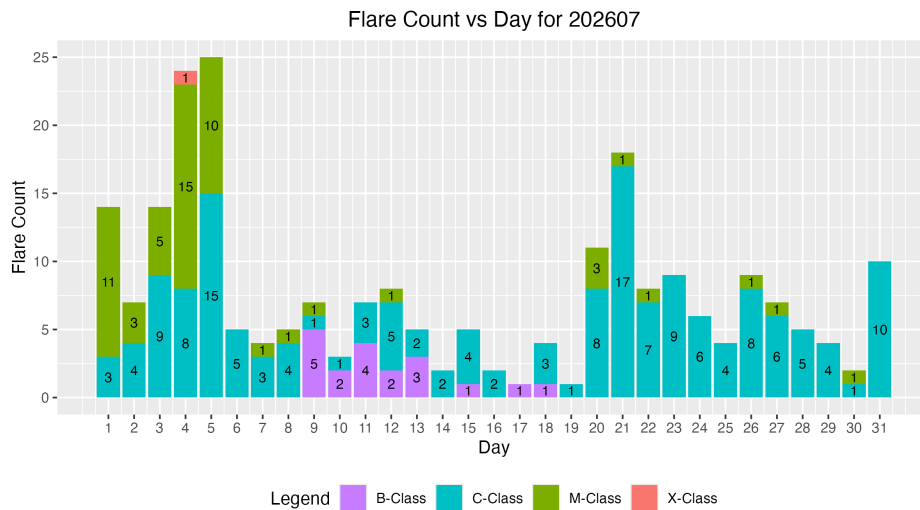


Figure 8: Solar Flare Summary from GOES-16 Data

3 Relative Sunspot Numbers (Ra)

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 the data assure error-free data are used to determine the monthly sunspot numbers

3.1 Raw Sunspot Counts

Figure 9 and 10, The raw daily sunspot counts consist of submitted counts from all observers who provided data in July 2026. 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.

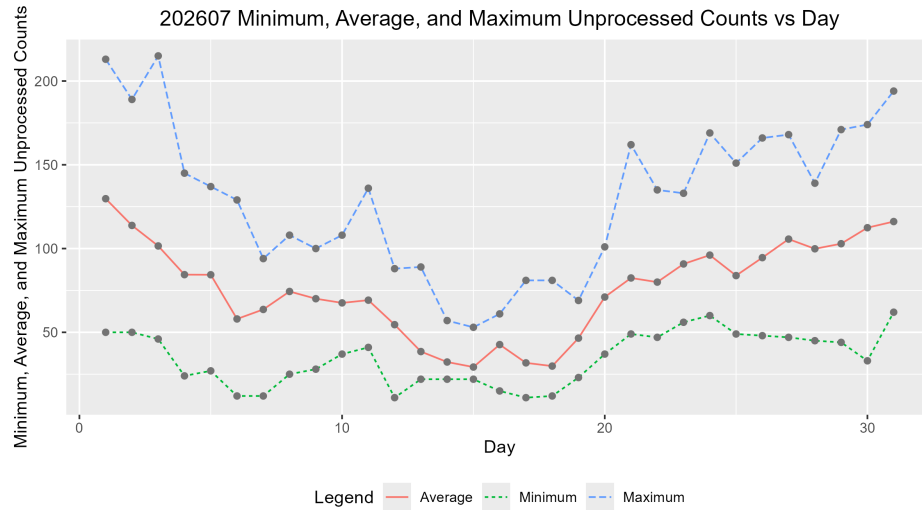


Figure 9: Minimum, Average, and Maximum Unprocessed Counts

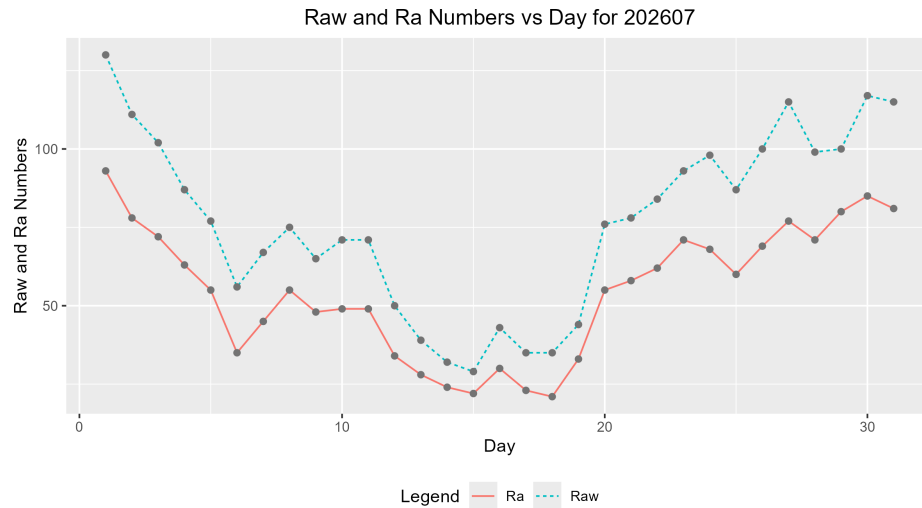


Figure 10: Raw Wolf average and Ra numbers by day of the month for all observers.

3.2 American Relative Sunspot Numbers

The relative sunspot numbers, Ra, represent the sunspot counts after the submitted data have been cleaned and processed using Shapley's method with k-factors (<http://iopscience.iop.org/article/10.1086/126109/pdf>). The Shapley method is a statistical model that combines random effects, such as observer group selection, and fixed effects, like seeing conditions. The raw Wolf averages and the calculated Ra are shown in Figure 7, while Table 2 presents the day of 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: 202607 American Relative Sunspot Numbers (R_a).

Day	Number of Observers	Raw	R_a
1	33	130	93
2	36	111	78
3	38	102	72
4	40	87	63
5	33	77	55
6	33	56	35
7	31	67	45
8	34	75	55
9	33	65	48
10	37	71	49
11	31	71	49
12	33	50	34
13	33	39	28
14	33	32	24
15	30	29	22
16	34	43	30
17	34	35	23
18	31	35	21
19	36	44	33
20	38	76	55
21	32	78	58
22	36	84	62
23	36	93	71
24	35	98	68
25	28	87	60
26	35	100	69
27	36	115	77
28	35	99	71
29	37	100	80
30	34	117	85
31	36	115	81
Averages	34.2	76.8	54.6

3.3 Sunspot Observers

Table3 lists the Observer Code(column1), the Number of Observations (column2) submitted for June 2026, and the Observer Name(column3). The final row gives the total number of observers who submitted sunspot counts(59),and total number of observations submitted(1160)

Table 3: Sunspot observers, Jul 2026.

Observer	Code	N
Alexandre Amorim	AAX	24
Gema Araujo	ARAG	32
Roberto Battaiola	BATR	7

continued on next page

Table 3: Sunspot observers, Jul 2026. (*continued*)

Observer	Code	N
John Blackwell	BKL	13
BESSON	BMIG	31
JESUS BLANCO GONZALEZ	BVZ	29
Jose Alberto Berdejo	BXZ	29
Gonzalo Vargas B	BZX	28
Brian Cudnik	CKB	28
CERVONI MAURIZIO	CMAB	10
Dean Chantiles	CNT	19
David Cowall	CWD	14
Aritra Das	DARB	10
FRANK DEMPSEY	DFR	24
giuseppe di tommaso	DGIA	9
William Gregory Dillon	DIL	25
Jorge del Rosario	DJOB	20
Jeffrey DeVries	DJSA	5
Deconinck Michel	DMIB	31
Pascal DABROWSKI	DPAL	21
Franky dubois	DUBF	31
Howard Eskildsen	EHOA	25
Allen Frohardt	FALB	12
Eric Fabrigat	FERA	23
Igor Grageda Mendez	GIGA	28
Kim Hay	HKY	24
Rodney Howe	HOWR	21
Timothy Hrutkay	HRUT	18
Luigi Iapichino	ILUB	10
David Jackson	JDAC	16
GERARDO	JGE	2
Simon Jenner	JSI	4
Amoli Kakkar	KAMB	31
Kandilli Observatory	KAND	28
John Kaplan	KAPJ	21
Tom Karnuta	KTOC	22
Kristine Larsen	LKR	4
Leroy Leonard	LLEC	31
Robert R Little	LRRA	25
Enrico Mariani	MARE	14
JOHN H MCCAMMON	MJHA	31
Michael Moeller	MMI	31
George Mudry	MUDG	16
Michael McShan	MWMB	3
Walter Jose maluf	MWU	27
Peter Crute	PCEA	11
Ludovic Perbet	PLUD	21
Javier Ruiz	RJV	24
David Scott	SDAW	20
Jan Alvestad	SDOH	31
Neil Simmons	SNE	9
Lance Shaw	SQN	10
Raidel Sosa Armas	SRAL	20
Ricardo A. St. Hilaire	SRIE	20
David Teske	TDE	28
Patrick Thibault	TPJB	3
Steve Toothman	TST	25

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Table 3: Sunspot observers, Jul 2026. (*continued*)

Observer	Code	N
Utku Demirhan	UDBA	1
PIOTR URBANSKI	URBP	30
59 observers	Total	1160

4 A Generalized Linear Mixed Model for Enumerated Sunspots

Dr. Jamie Riggs, Solar System Science Section Head, International Astrostatistics Association, maintains a relative sunspot number (Ra) 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 Ra in Section 2 above. The GLMM is a statistical model that accounts for variation due to random effects and fixed effects. For the GLMM Ra 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 11 shows the monthly GLMM Ra 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 Ra estimates of excellent seeing conditions, which in part explains why these Ra estimates often are higher than the Shapley Ra 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 Ra 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 25th through the 75th quartiles. The lower and upper whiskers extend 1.5 times the IQR below the 25th quartile, and 1.5 times the IQR above the 75th 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.

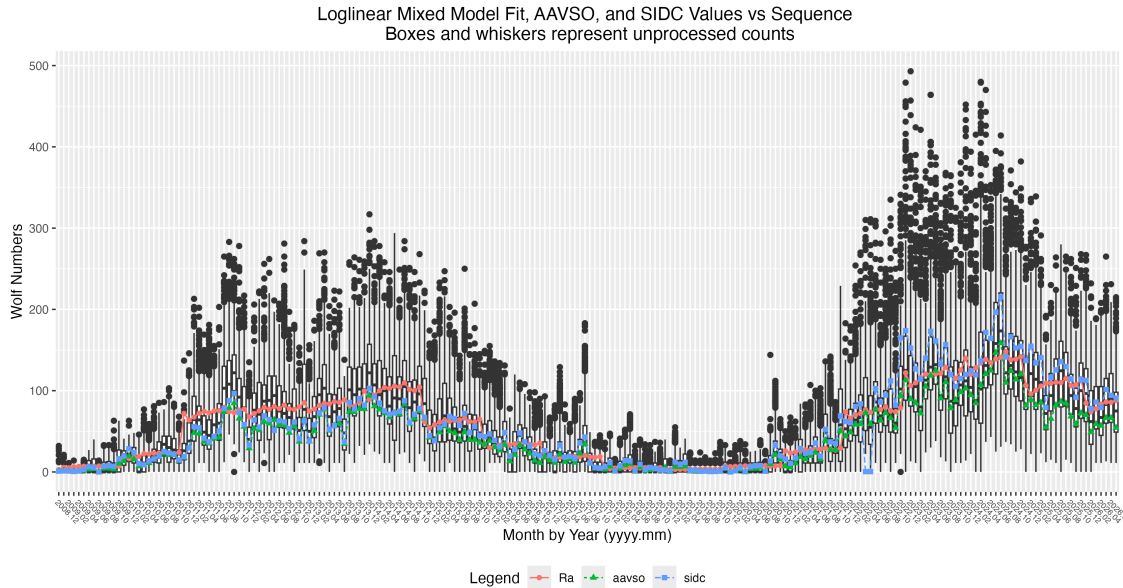


Figure 11: A Generalized Linear Mixed Model for Enumerated Sunspots

4 Endnotes

- Sunspot Reports: Kim Hay solar@aavso.org
- SID Solar Flare Reports: Rodney Howe rhowe137@icloud.com
- Sunspot data as of July 13, 2026

5 References

- Dr. Jamie Riggs (2017), Solar System Science Section Head, International Astrostatistics (using R Statistical Software (2023), TSA Libraries: (<https://cran.r-project.org>))
- Shapley, (1949), method with k-factors (<http://iopscience.iop.org/article/10.1086/126109/pdf>).
- U.S. Dept. of Commerce–NOAA, Space Weather Prediction Center, 2022. GOES-16 XRA data. <ftp://ftp.swpc.noaa.gov/pub/indices/events/>