Solar Bulletin

THE AMERICAN ASSOCIATION OF VARIABLE STAR OBSERVERS
SOLAR SECTION

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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 very low frequency (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 The Sun in the Spotlight: July 2025

Figure 1: Images of the solar wind from the Parker Solar Probes WISPR instrument, taken December 25, 2024. Credit: NASA/Johns Hopkins APL/Naval Research Lab

While Solar Cycle 25 continues its downward slide from maximum, the Sun still features numerous sunspot groups on most days. In fact, the last spotless day was in 2022. Our sunspot activity observations provide one set of data that is aggregated with observations beyond the photosphere (and beyond the visible part of the electromagnetic spectrum) to provide a richer understanding of solar activity in total. The following solar news items were noted in July 2025:

The Parker Solar Probe team released the closest images of the Sun ever taken (from 3.8 million miles above the photosphere): `https://science.nasa.gov/science-research/heliophysics/nasas-parker-solar-probe-snaps-closest-ever-images-to-sun/`

The NASA Helio Highlights blog discusses programs to monitor space weather threats to astronauts returning to the Moon: `https://science.nasa.gov/uncategorized/helio-highlights-july-2025/`

The July 30, 2025, Astronomy Picture of the Day (APOD) featured coronal loops on the Sun: `https://apod.nasa.gov/apod/ap250730.html`

July 14, 2025, marked the 25th anniversary of the Bastille Day Solar Event. A series of powerful solar flares and coronal mass ejections caused a G5 geomagnetic storm, resulting in remarkable auroral displays as well as significant high-frequency radio communications: `https://www.nesdis.noaa.gov/news/25th-anniversary-of-the-bastille-day-solar-event`

AAVSO Solar Interest Group co-leader Dr. Kristine Larsen gave an invited talk on safe solar observing at the annual Stellafane Convention in Springfield, Vermont. The video is available here: `https://www.youtube.com/watch?v=AfeiY-3PZXA&list=PL0EUY6vSGSRePxxb9yKk8iKJRChKtDnBl&index=5`

2 Sudden Ionospheric Disturbance (SID) Report

2.1 SID Records

July 2025 (Figure 2): On July 12th, 17 flares - 14 C-Class, and 3 M-Class - were recorded in Milan, Italy, by Lionel Laudet (A118). (U.S. Dept. of Commerce–NOAA, 2022).

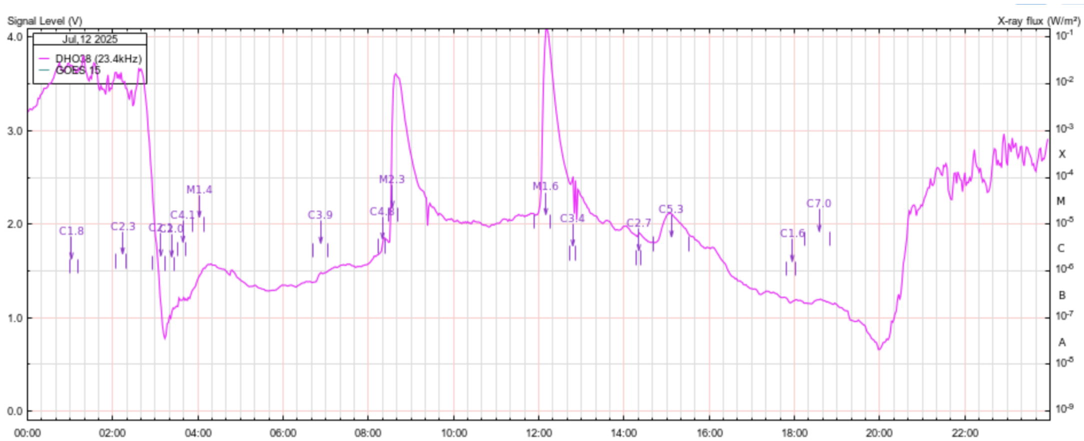

Figure 2: VLF recording from Milan, Italy for the 15th.

2.2 SID Observers

In July 2025 we had 11 AAVSO SID observers who submitted VLF data as listed in Table 1.

Table 1: 202507 VLF Observers

Observer	Code	Stations
R Battaiola	A96	HWU
J Wallace	A97	NAA
L Loudet	A118	DHO
J Godet	A119	DHO GBZ GQD
J Karlovsky	A131	DHO
R Mrllak	A136	NSY
L Pina	A148	NAA NML
J Wendler	A150	NAA
H Krumnow	A152	DHO GBZ
J DeVries	A153	NLK
M Cervoni	A154	DHO ICV

Figure 3 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.

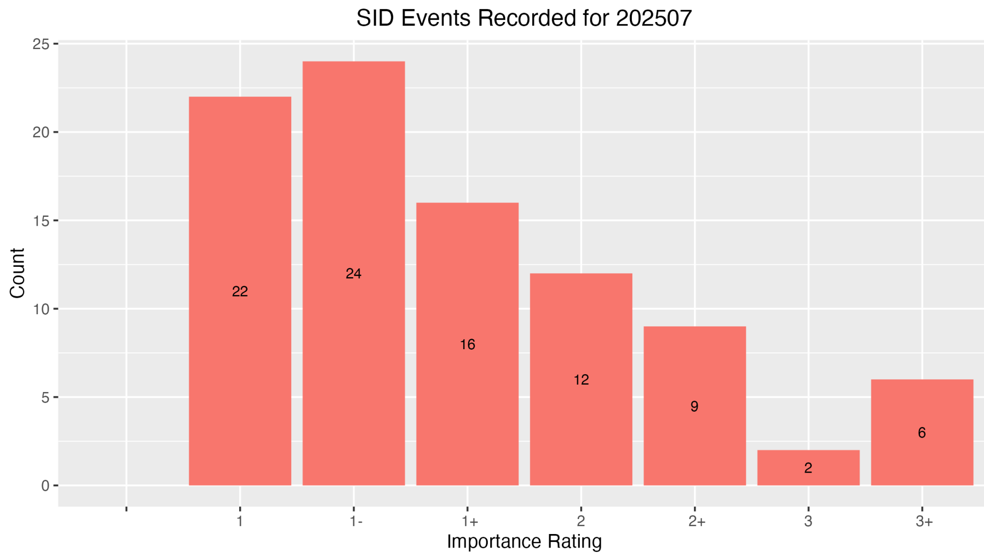

Figure 3: VLF SID Events.

2.3 Solar Flare Summary from GOES-16 Data

In July 2025, there were 200 GOES-16 XRA flares: 5 M-class, 186 C-class, and 9 B-class. Far less flaring this month compared to last month. (U.S. Dept. of Commerce–NOAA, 2022). (see Figure 4).

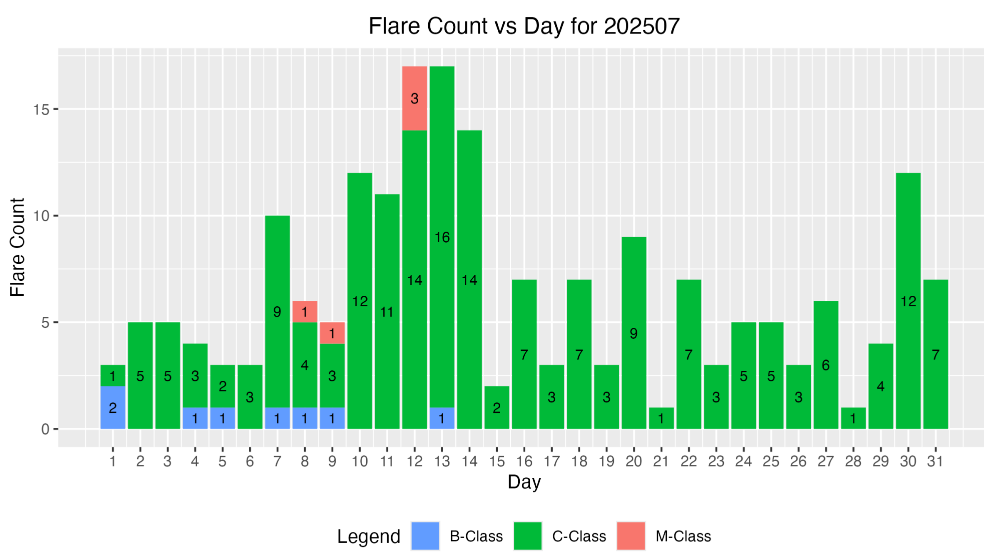

Figure 4: GOES-16 XRA flares (U.S. Dept. of Commerce–NOAA, 2022).

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 the data 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 July 2025. 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 5.

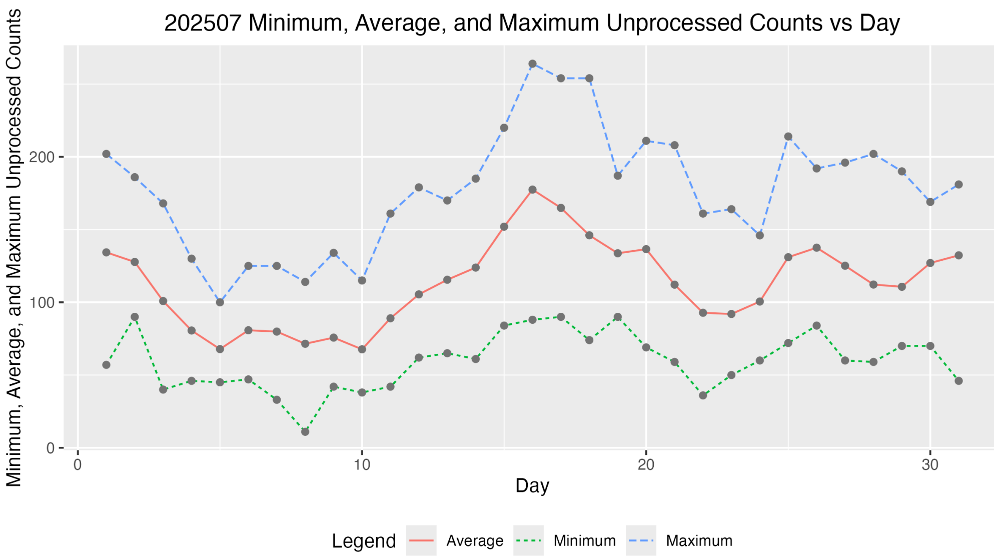

Figure 5: Raw Wolf number average, minimum and maximum by day of the month for all observers.

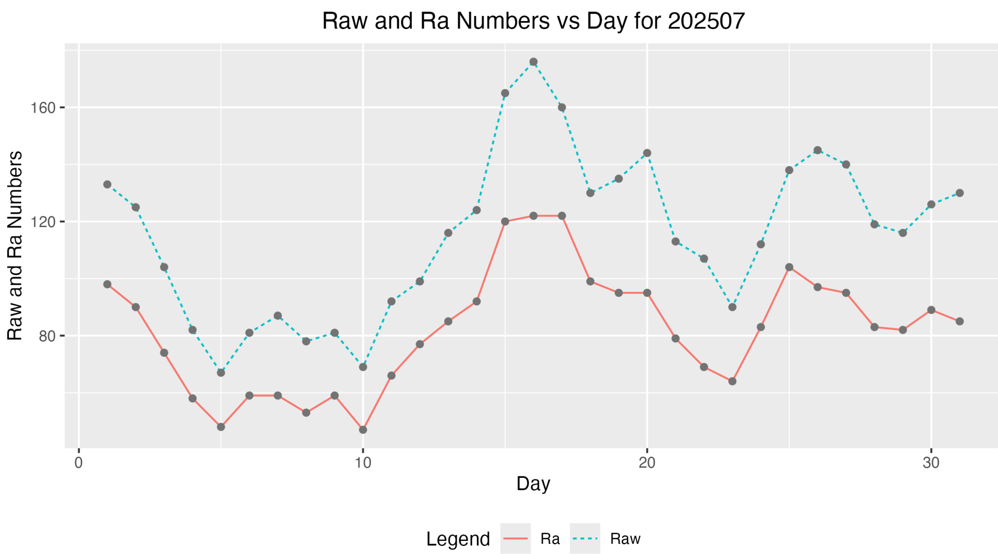

Figure 6: Raw Wolf average and R_a numbers by day of the month for all observers.

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`). The Shapley method is a statistical model that agglomerates variation due to random effects, such as observer group selection, and fixed effects, such as seeing condition. The raw Wolf averages and calculated R_a are seen in Figure 6, 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: 202507 American Relative Sunspot Numbers (R_a).

Day	Number of Observers	Raw	R_a
1	33	133	98
2	31	125	90
3	29	104	74
4	37	82	58
5	33	67	48
6	31	81	59
7	24	87	59
8	30	78	53
9	29	81	59
10	31	69	47
11	35	92	66
12	29	99	77
13	36	116	85
14	33	124	92
15	33	165	120

Continued

Table 2: 202507 American Relative Sunspot Numbers (R_a).

Day	Number of Observers	Raw	R_a
16	32	176	122
17	31	160	122
18	32	130	99
19	27	135	95
20	28	144	95
21	32	113	79
22	30	107	69
23	27	90	64
24	28	112	83
25	27	138	104
26	26	145	97
27	29	140	95
28	29	119	83
29	30	116	82
30	31	126	89
31	24	130	85
Averages	30.2	115.6	82.2

3.3 Sunspot Observers

Table 3 lists the Observer Code (column 1), the Number of Observations (column 2) submitted for July 2025, and the Observer Name (column 3). The final row gives the total number of observers who submitted sunspot counts (55), and total number of observations submitted (937).

Table 3: 202507 Number of observations by observer.

Observer Code	Number of Observations	Observer Name
AAX	27	Alexandre Amorim
AJEE	8	Jean Rodrigo Adacheski
AJV	25	J. Alonso
ASA	3	Salvador Aguirre
BATR	5	Roberto Battaiola
BKL	17	John A. Blackwell
BMIG	28	Michel Besson
BTB	11	Thomas Bretl
BVZ	21	Jesus E. Blanco
BXZ	29	Jose Alberto Berdejo
CKB	25	Brian Cudnik
CMAB	19	Maurizio Cervoni
CNT	29	Dean Chantiles
CWD	13	David Cowall

Continued

Table 3: 202507 Number of observations by observer.

Observer Code	Number of Observations	Observer Name
DARB	14	Aritra Das
DGIA	7	Giuseppe di Tommasco
DJOB	10	Jorge del Rosario
DJSA	1	Jeff DeVries
DJVA	30	Jacques van Delft
DMIB	27	Michel Deconinck
DUBF	28	Franky Dubois
EHOA	4	Howard Eskildsen
FERA	28	Eric Fabrigat
FJOF	1	Joe Fazio
GCNA	6	Cndido Gmez
GIGA	30	Igor Grageda Mendez
HALB	17	Brian Halls
HKY	26	Kim Hay
HOWR	15	Rodney Howe
ILUB	2	Luigi Iapichino
JGE	7	Gerardo Jimenez Lopez
JSI	5	Simon Jenner
KAND	31	Kandilli Observatory
KAPJ	19	John Kaplan
KNJS	23	James & Shirley Knight
KTOC	24	Tom Karnuta
LKR	6	Kristine Larsen
LRRA	26	Robert Little
MARC	3	Arnaud Mengus
MARE	11	Enrico Mariani
MCE	24	Etsuiku Mochizuki
MJHA	30	John McCammon
MMI	31	Michael Moeller
MUDG	11	George Mudry
MWU	24	Walter Maluf
NMID	5	Milena Niemczyk
PLUD	21	Ludovic Perbet
RJV	24	Javier Ruiz Fernandez
SNE	6	Neil Simmons
SRIE	17	Rick St. Hilaire
TDE	23	David Teske
TST	21	Steven Toothman
URBP	25	Piotr Urbanski
WGI	1	Guido Wollenhaupt
WND	13	Denis Wallian
Totals	937	55

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 7 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.

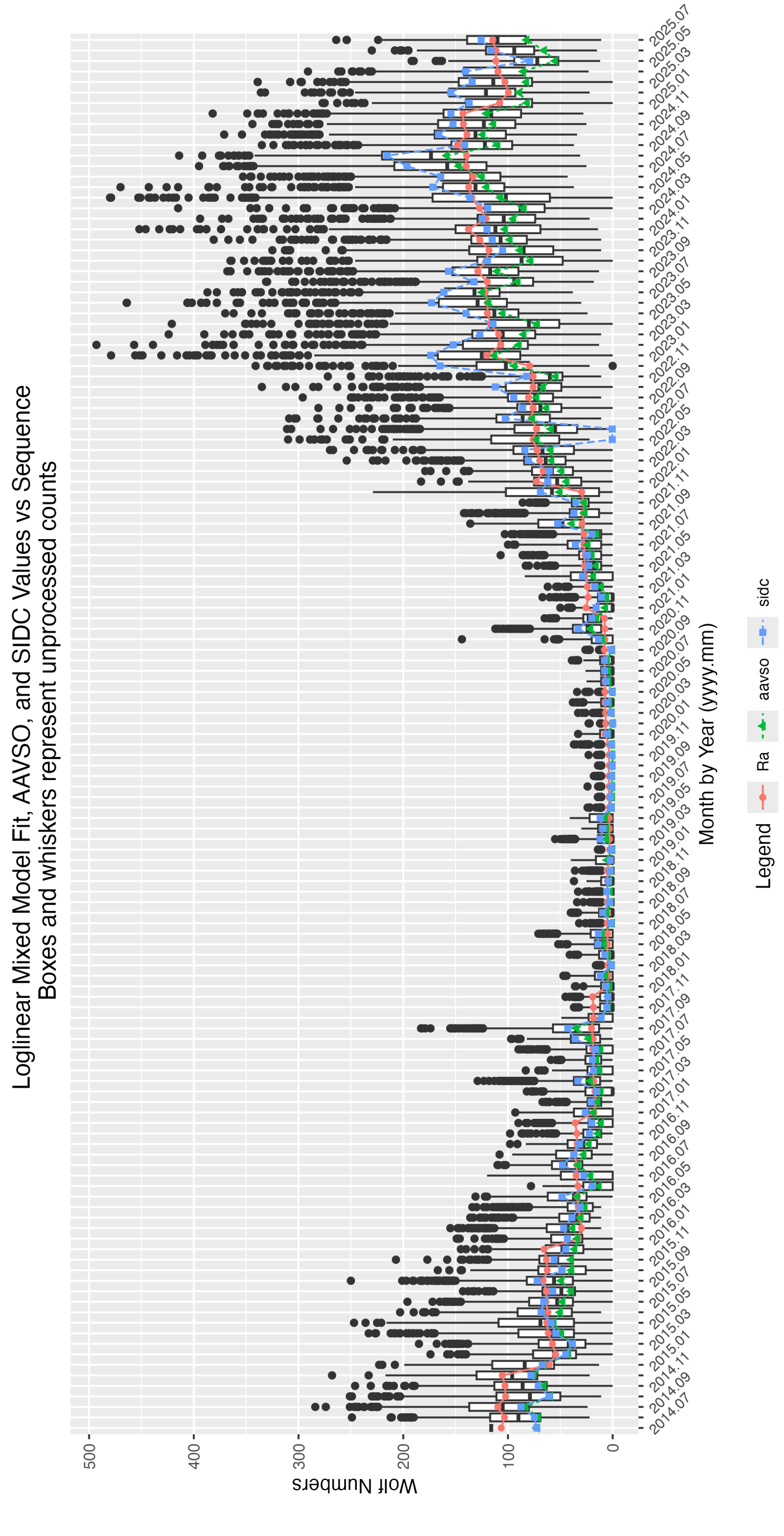

Figure 7: GLMM fitted data for R_a. AAVSO data: https://www.aavso.org/category/tags/solar-bulletin. SIDC data: WDC-SILSO, Royal Observatory of Belgium, Brussels

4 Endnotes

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

5 Antique telescope project

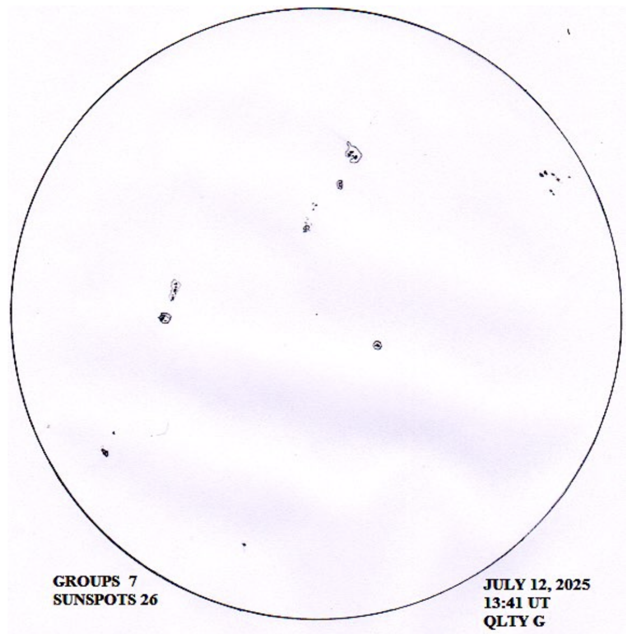

Figure 8: A recent replica of an antique telescope built by Gonzalo Vargas (BZX) in Cochabamba Bolivia (left), and a drawing for July 12 (right).

6 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, H. (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/`