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 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 Antique VLF radios

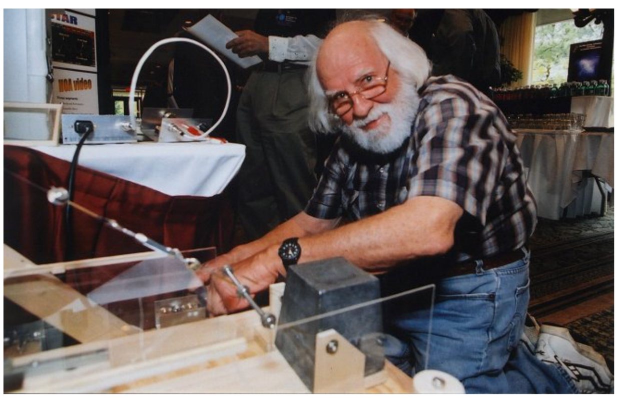

Figure 1: Casper (Cap) Hossfield's advice on building Gyrator radios (left) (Hossfield 1994; Stokes 1999), Andries Son's (A112) hexagon loop designed by Hossfield (right).

"I use the system of Caspar (sic) Hossfield; a hexagonal loop antenna with the receiver. I did get a lot of information thanks to the emails of Caspar (sic) in 2002. I use a computer with a 4 channels logger to get the graphs of the SID's and a computer program of Velleman. I send you a photo of the loop antenna in my garden, 30 meters away from my home." Andries Son (A112)

Andy Clerkin (A-29) wrote in 2003: "It's amazing how much influence one man can have on the world. Cap was knowledgeable in so many areas and was always so willing to share his expertise with others. Regrettably, I never met Cap and yet he still had a strong influence on my life. I first became aware of Cap back in 1969 during my junior year of high school. It was then that I read an article that he had written in *Sky And Telescope (April 1969)* regarding the detection of solar flares using radio equipment. It is now 33 years later and I still enjoy this subject as much as I ever did. I can't imagine the number of people Cap similarly influenced in such a positive way over his lifetime. He is truly a legend and will never be forgotten."

2 Sudden Ionospheric Disturbance (SID) Report

2.1 SID Records

July 2023 (Figure 2): There were several M-Class flares during the daytime recorded in Fort Collins, Colorado, where we can see C-Class SID Events during day time hours on the 16th of July.

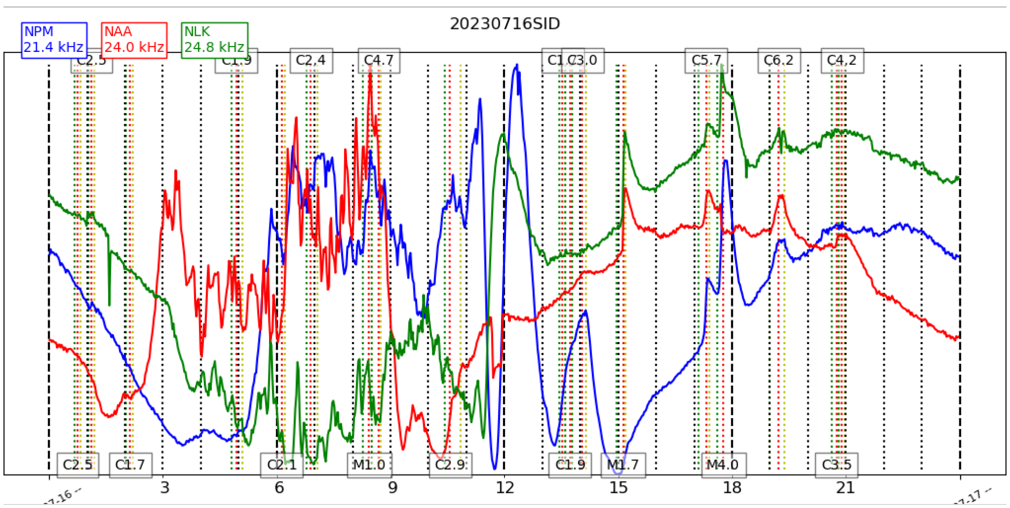

Figure 2: VLF recording from Fort Collins, CO.

2.2 SID Observers

In July 2023 we had 15 AAVSO SID observers who submitted VLF data as listed in Table 1.

Table 1: 202307 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 NAU NLK
L Pina	A148	NAA NLK
J Wendler	A150	NAA
H Krumnow	A152	DHO FTA GBZ
J DeVries	A153	NLK
M Salo	A157	NLK

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.

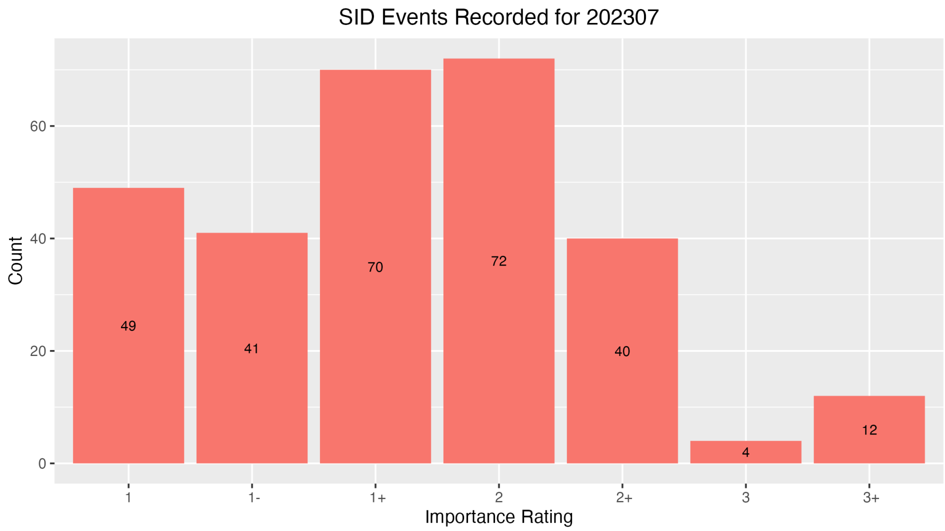

Figure 3: VLF SID Events.

2.3 Solar Flare Summary from GOES-16 Data

In July 2023, there were 329 GOES-16 XRA flares: one X class, 50 M class, and 278 C class. There was more flaring this month than last. (U.S. Dept. of Commerce–NOAA, 2022). (see Figure 4).

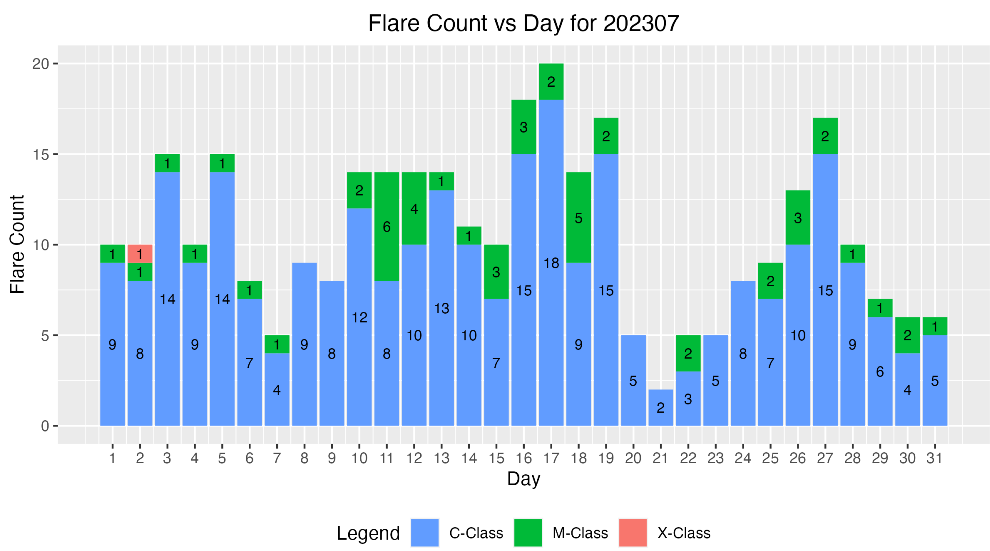

Figure 4: GOES-16 XRA flares (U.S. Dept. of Commerce–NOAA, 2022).

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 2023. 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.

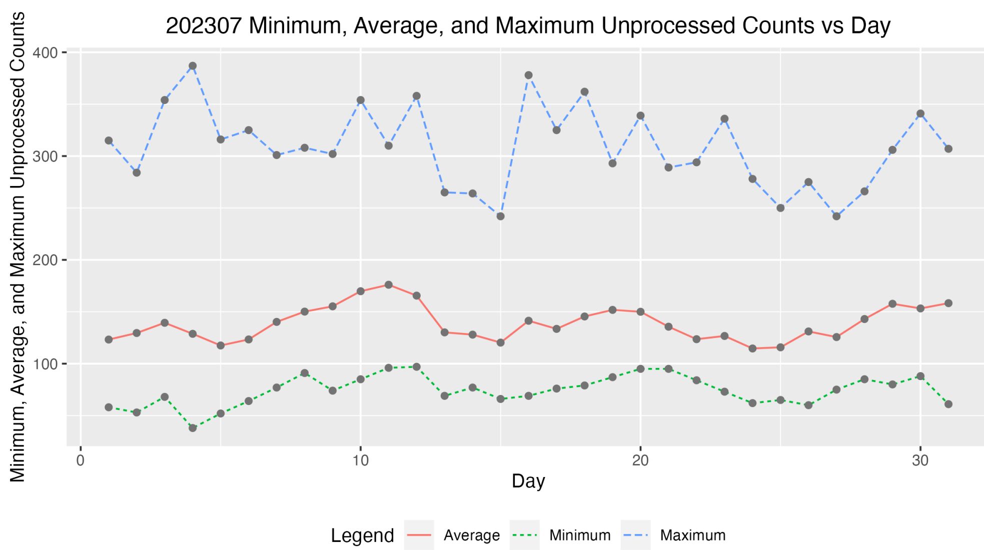

Figure 5: Raw Wolf number average, minimum and maximum by day of the month for all observers.

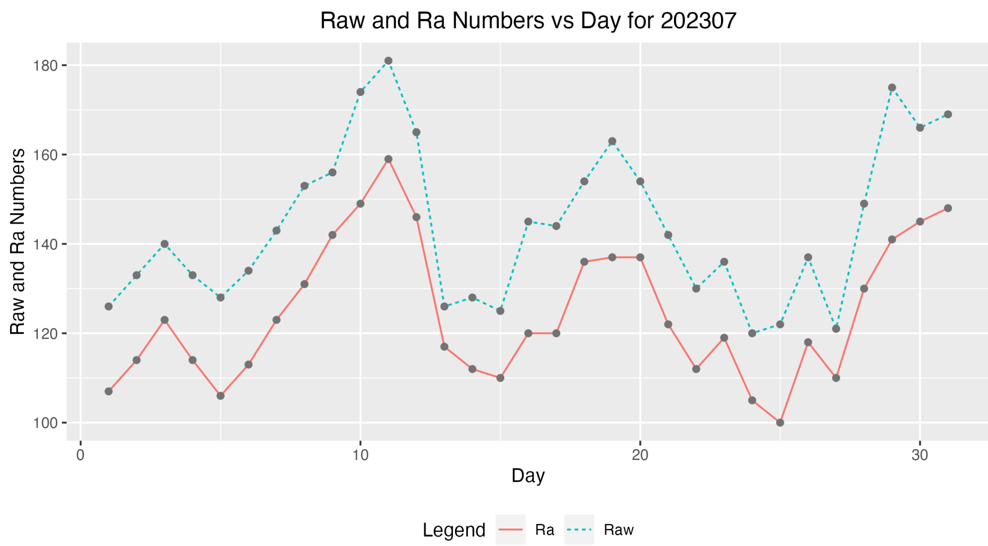

Figure 6: Raw Wolf average and R_a numbers by day of the month for all observers.

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: 202307 American Relative Sunspot Numbers (R_a).

Day	Number of Observers	Raw	R_a
1	35	126	107
2	41	133	114
3	37	140	123
4	41	133	114
5	38	128	106
6	46	134	113
7	45	143	123
8	40	153	131
9	40	156	142
10	40	174	149
11	32	181	159
12	38	165	146
13	40	126	117
14	39	128	112
15	37	125	110

Continued

Table 2: 202307 American Relative Sunspot Numbers (R_a).

Day	Number of Observers	Raw	R_a
16	35	145	120
17	40	144	120
18	44	154	136
19	32	163	137
20	45	154	137
21	36	142	122
22	44	130	112
23	40	136	119
24	38	120	105
25	39	122	100
26	42	137	118
27	30	121	110
28	37	149	130
29	36	175	141
30	41	166	145
31	37	169	148
Averages	38.9	144.3	124.7

3.3 Sunspot Observers

Table 3 lists the Observer Code (column 1), the Number of Observations (column 2) submitted for July 2023, and the Observer Name (column 3). The final row gives the total number of observers who submitted sunspot counts (70), and total number of observations submitted (1221).

Table 3: 202307 Number of observations by observer.

Observer Code	Number of Observations	Observer Name
AAX	13	Alexandre Amorim
ARAG	31	Gema Araujo
ASA	4	Salvador Aguirre
BATR	10	Roberto Battaiola
BKL	8	John A. Blackwell
BMF	17	Michael Boschat
BMIG	29	Michel Besson
BROB	20	Robert Brown
BXZ	27	Jose Alberto Berdejo
BZX	25	A. Gonzalo Vargas
CKB	20	Brian Cudnik
CLDB	18	Laurent Cambon
CMAB	8	Maurizio Cervoni
CNT	31	Dean Chantiles

Continued

Table 3: 202307 Number of observations by observer.

Observer Code	Number of Observations	Observer Name
CVJ	13	Jose Carvajal
DARB	23	Aritra Das
DELS	3	Susan Delaney
DFR	13	Frank Dempsey
DJOB	10	Jorge del Rosario
DJSA	6	Jeff DeVries
DJVA	19	Jacques van Delft
DMIB	13	Michel Deconinck
DUBF	29	Franky Dubois
EHOA	23	Howard Eskildsen
ERB	29	Bob Eramia
FERA	28	Eric Fabrigat
FLET	29	Tom Fleming
GIGA	24	Igor Grageda Mendez
HALB	18	Brian Halls
HKY	24	Kim Hay
HOWR	18	Rodney Howe
HSR	9	Serge Hoste
IEWA	21	Ernest W. Iverson
ILUB	2	Luigi Iapichino
JGE	7	Gerardo Jimenez Lopez
JSI	4	Simon Jenner
KAND	29	Kandilli Observatory
KAPJ	20	John Kaplan
KNJS	29	James & Shirley Knight
KSOB	16	Souvik Karmokar
KTOC	16	Tom Karnuta
KZAD	11	Zachary Knoles
LKR	4	Kristine Larsen
LRRA	10	Robert Little
LVY	15	David Levy
MARC	6	Arnaud Mengus
MARE	10	Enrico Mariani
MCE	22	Etsuiku Mochizuki
MJHA	30	John McCammon
MLL	10	Jay Miller
MMI	31	Michael Moeller
MSS	11	Sandy Mesics
MUDG	4	George Mudry
MWMB	26	William McShan
MWU	22	Walter Maluf
ONJ	5	John O'Neill
PLUD	25	Ludovic Perbet

Continued

Table 3: 202307 Number of observations by observer.

Observer Code	Number of Observations	Observer Name
RJV	22	Javier Ruiz Fernandez
SDOH	31	Solar Dynamics Obs - HMI
SNE	4	Neil Simmons
SRIE	24	Rick St. Hilaire
TDE	25	David Teske
TNIA	9	Nick Tonkin
TPJB	5	Patrick Thibault
TST	29	Steven Toothman
URBP	29	Piotr Urbanski
VIDD	15	Dan Vidican
WGI	2	Guido Wollenhaupt
WND	19	Denis Wallian
WWM	29	William M. Wilson
Totals	1221	70

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.

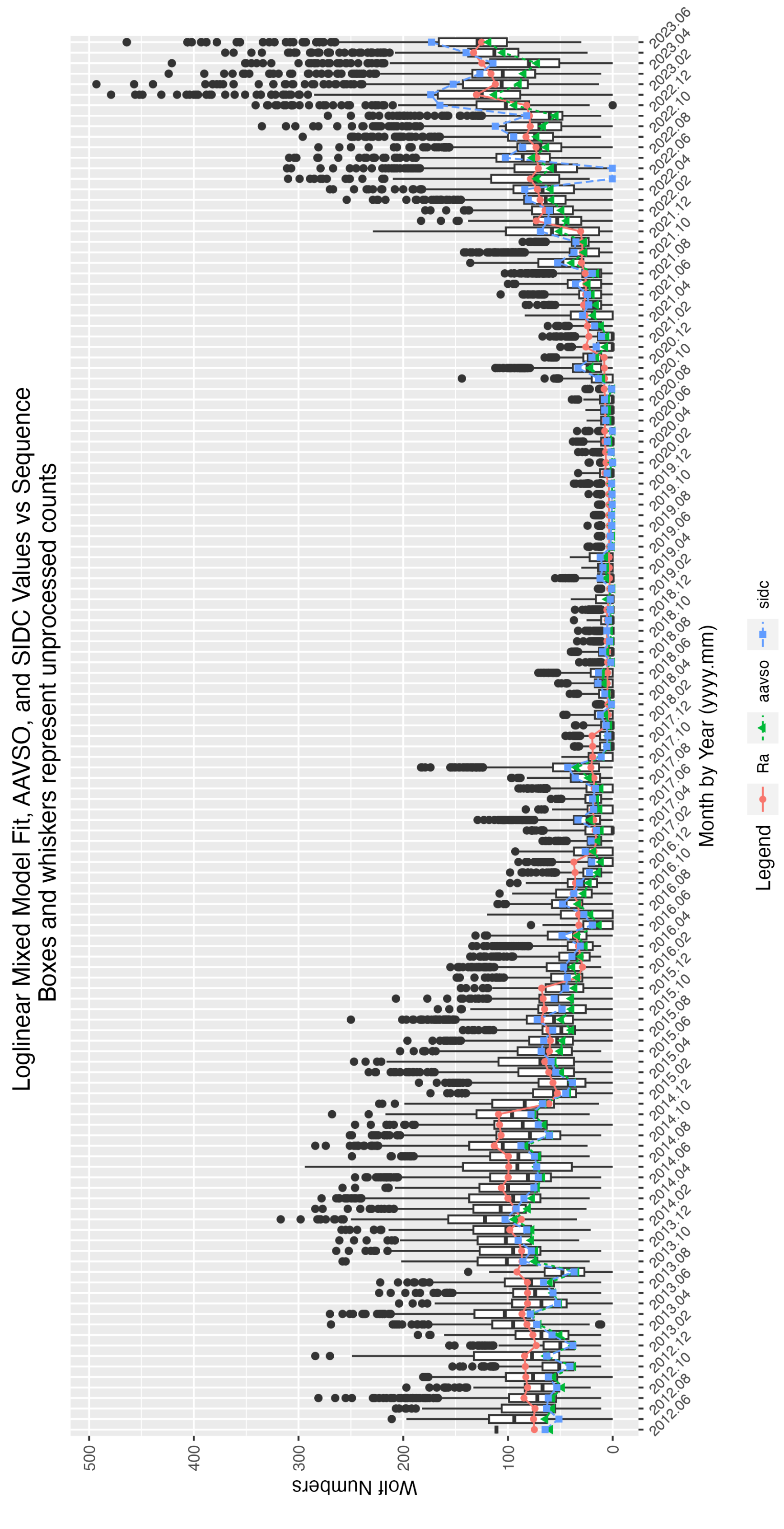

Figure 7: GLMM fitted data for R_a. AAVSO data: https://www.aavso.org/category/tags/solar-bulletin. SIDC data: WDC-SILSO, Royal Observatory of Belgium, Brussels

4 Endnotes

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

4.1 Observing Sunspots CHOICE course

With the increase in solar activity, now is a great time to learn more about counting sunspots and improving your skills by signing up for a course being taught by AAVSO member and observer Raffaello Braga: Observing and Counting Sunspots - September 4 to September 30, 2023. To learn more about the course please visit: `https://www.aavso.org/choice-course-descriptions#Sunspots` To sign up go here (must enroll by August): `https://www.aavso.org/choice-astronomy`

4.2 Antique telescope project

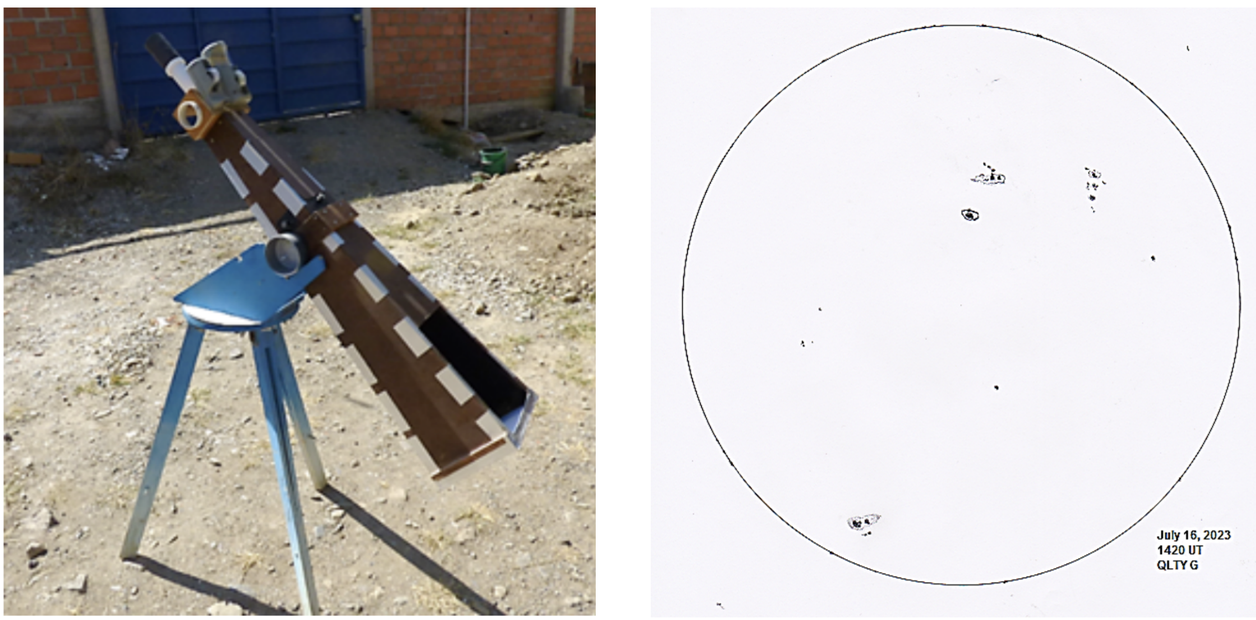

Figure 8: A recent replica of an antique telescope built by Gonzalo Vargas (BZX) (left), and a drawing for July 16 (right).

5 References

Hossfield, C. 1994, *A Simple, Easy-To-Build, SID Receiver* https://www.aavso.org/simple-easy-build-sid-receiver

Stokes, Arthur J. 1999, "A Gyrator Tuned VLF Receiver", *Communications Quarterly*, Spring 1994, pgs 24-26. https://www.aavso.org/minimal-gyrator-ii-vlf-receiver

U.S. Dept. of Commerce–NOAA, Space Weather Prediction Center. (2022). GOES-16 XRA data ftp://ftp.swpc.noaa.gov/pub/indices/events/