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 Elizabeth Brown, Solar Observer

Figure 1: Elizabeth Brown (1830-1899) with her 3-inch Wray refractor set up for solar projection.

Amateur astronomer Elizabeth Brown (1830-99) served as Solar Section Director of the LAS from

1883 until its demise in 1890. Afterwards she became a driving force behind the formation of the British Astronomical Association (BAA) in 1890. Brown became the Director of the BAA Solar Section, a post she held until her death in 1899.

Brown's love of amateur astronomy and meteorology were kindled working alongside her father, wine merchant Thomas Crother Brown, who was widowed when Elizabeth was only 11 years old (Anon 1899). In 1871 she took over the responsibility of making and submitting meteorological observations to the Royal Meteorological Society and published a number of her own astronomical observations, especially of sunspots, aurorae, meteors, and the zodiacal light. After her father's death in 1883 (at the age of 91), she was able to concentrate on her astronomical observations, and became the Director of the "Liverpool Astronomical Society" (LAS) Solar Section (Creese 1998). When the LAS fell into decline, Brown was one of the more vocal proponents for the founding of a new society, and with the help of Royal Greenwich Observatory solar astronomer Edward Walter Maunder the BAA was formed. She became the Director of the Solar Section and also contributed both observations and administrative support to other sections.

In her role as Solar Section Director she not only aggregated solar observations from observers from around the globe, but worked closely with solar astronomer Edward Maunder and other professionals in an attempt to garner specific types of observations from BAA members in order to answer a number of astronomical questions of the day. For example, she encouraged the monitoring of the growth and decay of sunspot groups (Brown 1895) and published a number of her own observations of particular groups, urging observers to note whether faculae were seen both before and after the birth of sunspots in a given region, a topic of controversy at that time (Brown 1899). Her detailed work was used by John S. Townsend to argue, in 1895, that the reason why many sunspot groups were seen to grow when seen on the eastern limb and decay when approaching the western limb was due to the fact that most sunspot groups do not live more than two weeks (Brown 1896).

Brown was also responsible for recruiting new solar observers and giving basic instructions on the proper (and safe) technique. For example, in an 1891 article in the PASP Brown encouraged readers not only by explaining that professional-grade experience and equipment are not a prerequisite for useful observations, but by sharing details of her own beginnings in solar observing (using a 3-inch telescope to project the sun's image). Brown was also an eclipse chaser, but was only successful in viewing one of the three she traveled to.

Anon. (1899) Elizabeth Brown In Memoriam. JBAA 9(1899): 214-5.
Brown, E. (1891) A Few Hints to Beginners in Solar Observations. PASP 3: 172-5.
—— (1895) Growth and Decay of Sun-spots. JBAA 5: 460-1.
—— (1896) Growth and Decay of Sun-spots. JBAA 6: 170-1.
—— (1899) The Relation of Faculae to Sun-spots. JBAA 9: 116.
Creese, M.R.S. (1998) Elizabeth Brown (1830-1899), Solar Astronomer. JBAA 108 (4):1937.
https://articles.adsabs.harvard.edu//full/1998JBAA..108..193C/0000197.000.html

2 Sudden Ionospheric Disturbance (SID) Report

2.1 SID Records

November 2023 (Figure 2): The most active day recorded here in Fort Collins, Colorado was on the 14th of November with 22 C-class and 1 M Class event.

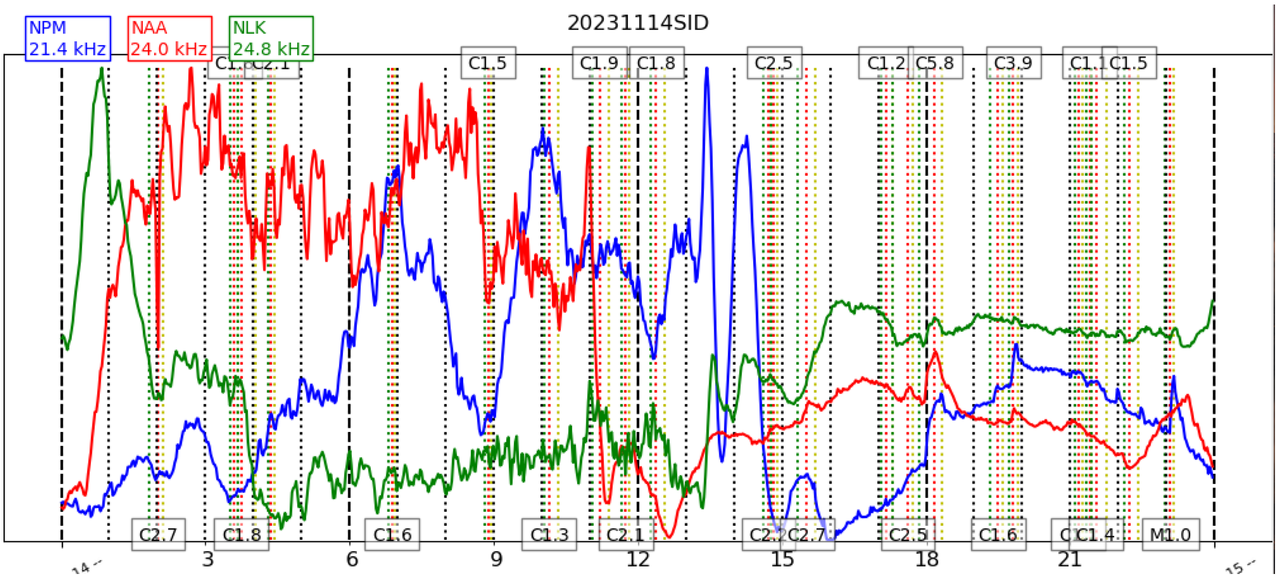

Figure 2: VLF recording from Fort Collins, CO.

2.2 SID Observers

In November 2023 we had 14 AAVSO SID observers who submitted VLF data, as listed in Table 1.

Table 1: 202311 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
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.

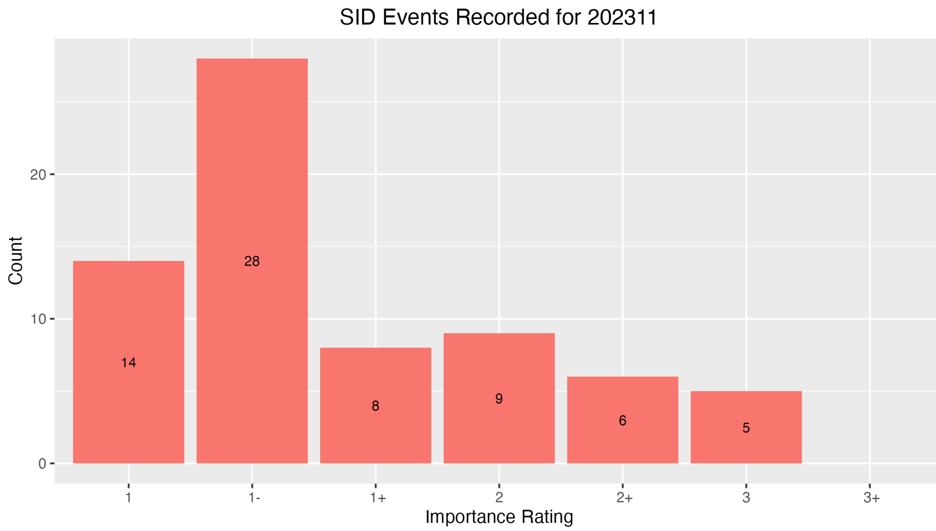

Figure 3: VLF SID Events.

2.3 Solar Flare Summary from GOES-16 Data

In November 2023, There were 224 GOES-16 XRA flares: 208 C-Class, and 16 M-Class, far less flaring this month compared to last. (U.S. Dept. of Commerce–NOAA, 2022; see Figure 4).

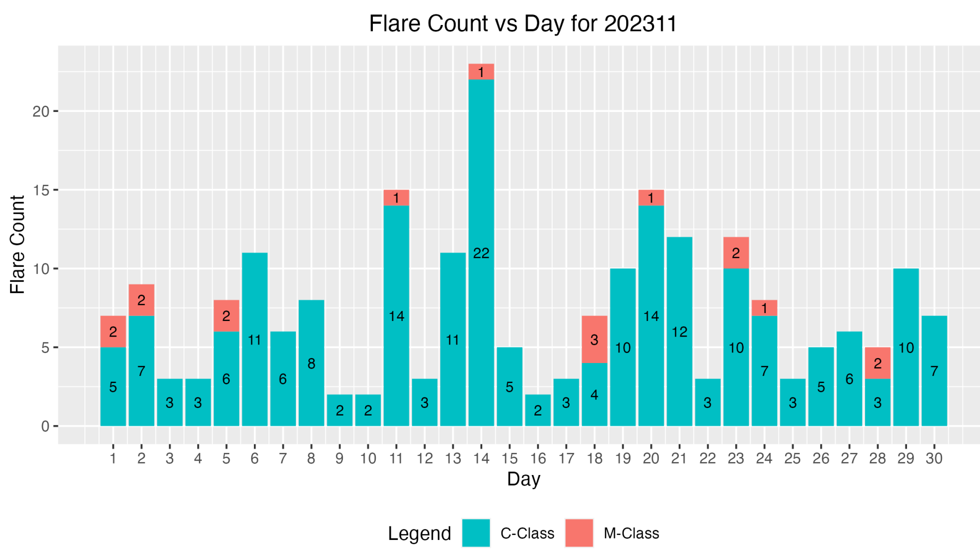

Figure 4: GOES-16 XRA flares (U.S. Dept. of Commerce–NOAA, 2022).

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 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 November 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.

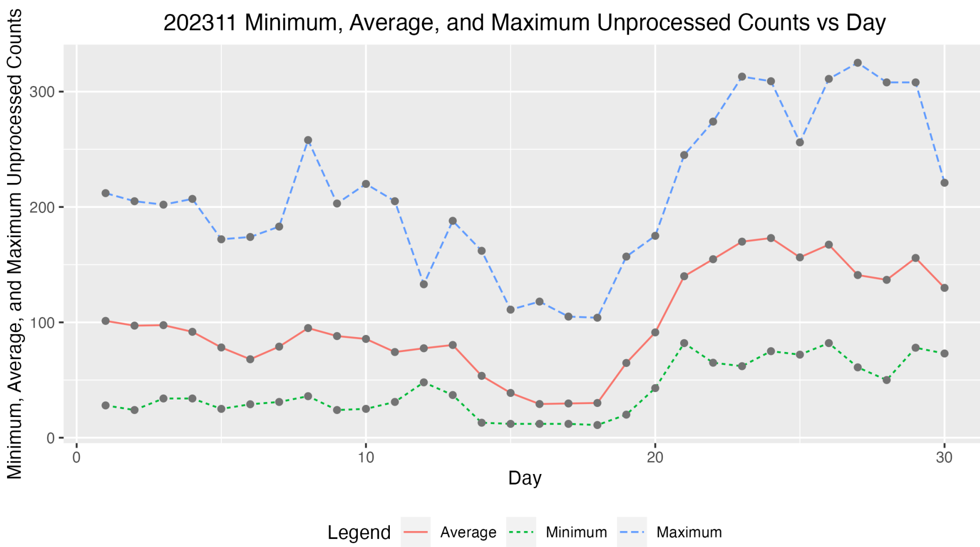

Figure 5: Raw Wolf number average, minimum and maximum by day of the month for all observers.

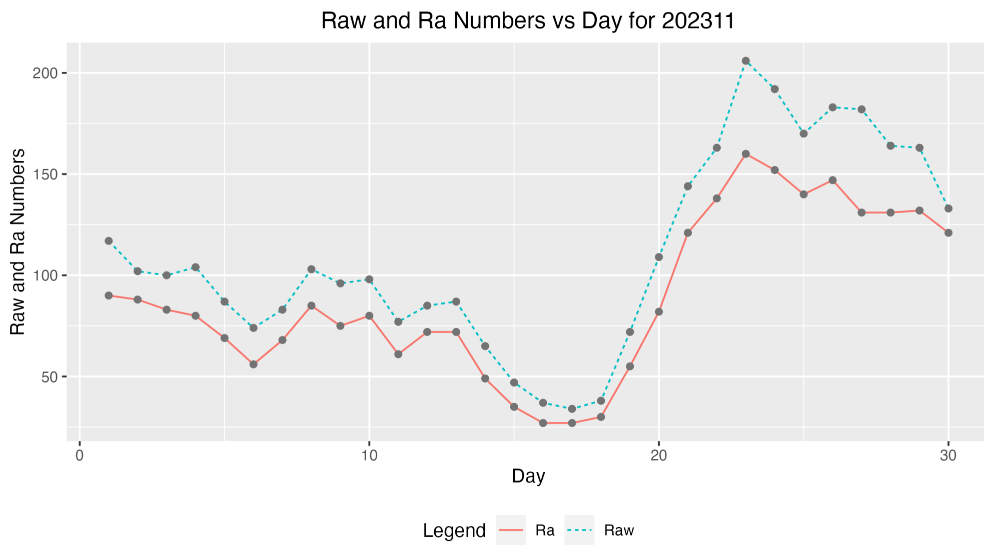

Figure 6: Raw Wolf average and R_a numbers by day of the month for all observers.

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`). 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: 202311 American Relative Sunspot Numbers (R_a).

Day	Number of Observers	Raw	R_a
1	27	117	90
2	28	102	88
3	30	100	83
4	25	104	80
5	39	87	69
6	31	74	56
7	37	83	68
8	38	103	85
9	28	96	75
10	29	98	80
11	34	77	61
12	34	85	72
13	37	87	72
14	24	65	49
15	36	47	35
16	30	37	27
17	32	34	27

Continued

Table 2: 202311 American Relative Sunspot Numbers (R_a).

Day	Number of Observers	Raw	R_a
18	36	38	30
19	35	72	55
20	27	109	82
21	28	144	121
22	34	163	138
23	34	206	160
24	31	192	152
25	36	170	140
26	23	183	147
27	26	182	131
28	29	164	131
29	36	163	132
30	26	133	121
Averages	31.3	110.5	88.6

3.3 Sunspot Observers

Table 3 lists the Observer Code (column 1), the Number of Observations (column 2) submitted for November 2023, and the Observer Name (column 3). The final row gives the total number of observers who submitted sunspot counts (66), and total number of observations submitted (940).

Table 3: 202311 Number of observations by observer.

Observer Code	Number of Observations	Observer Name
AAX	20	Alexandre Amorim
AJV	24	J. Alonso
ARAG	28	Gema Araujo
ASA	2	Salvador Aguirre
BATR	6	Roberto Battaiola
BKL	14	John A. Blackwell
BMF	16	Michael Boschat
BMIG	12	Michel Besson
BROB	28	Robert Brown
BXZ	18	Jose Alberto Berdejo
BZX	21	A. Gonzalo Vargas
CIOA	1	Ioannis Chouinavas
CKB	22	Brian Cudnik
CLDB	6	Laurent Cambon
CMAB	11	Maurizio Cervoni
CMOD	1	Moise Carlo
CNT	29	Dean Chantiles

Continued

Table 3: 202311 Number of observations by observer.

Observer Code	Number of Observations	Observer Name
DARB	24	Aritra Das
DELS	2	Susan Delaney
DFR	5	Frank Dempsey
DGIA	8	Giuseppe di Tommasco
DJOB	13	Jorge del Rosario
DJSA	8	Jeff DeVries
DJVA	22	Jacques van Delft
DMIB	19	Michel Deconinck
DUBF	14	Franky Dubois
EGMA	1	Georgios Epitropou
EHOA	12	Howard Eskildsen
ERB	14	Bob Eramia
FALB	21	Allen Frohardt
GIGA	27	Igor Grageda Mendez
HALB	9	Brian Halls
HKY	16	Kim Hay
HOWR	20	Rodney Howe
HSR	10	Serge Hoste
IEWA	15	Ernest W. Iverson
ILUB	2	Luigi Iapichino
JGE	3	Gerardo Jimenez Lopez
JSI	4	Simon Jenner
KAND	19	Kandilli Observatory
KAPJ	7	John Kaplan
KNJS	30	James & Shirley Knight
KTOC	6	Tom Karnuta
LKR	15	Kristine Larsen
LVY	30	David Levy
MARC	5	Arnaud Mengus
MARE	14	Enrico Mariani
MCE	21	Etsuiku Mochizuki
MJAF	24	Juan Antonio Moreno Quesada
MJHA	25	John McCammon
MLL	10	Jay Miller
MMI	30	Michael Moeller
MWU	17	Walter Maluf
ONJ	9	John O'Neill
PLUD	14	Ludovic Perbet
RARD	1	Arnav Ranjekar
RJV	10	Javier Ruiz Fernandez
SNE	11	Neil Simmons
SQN	19	Lance Shaw
SRIE	15	Rick St. Hilaire

Continued

Table 3: 202311 Number of observations by observer.

Observer Code	Number of Observations	Observer Name
TDE	12	David Teske
TNIA	4	Nick Tonkin
TST	23	Steven Toothman
URBP	12	Piotr Urbanski
VIDD	11	Dan Vidican
WWM	18	William M. Wilson
Totals	940	66

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.

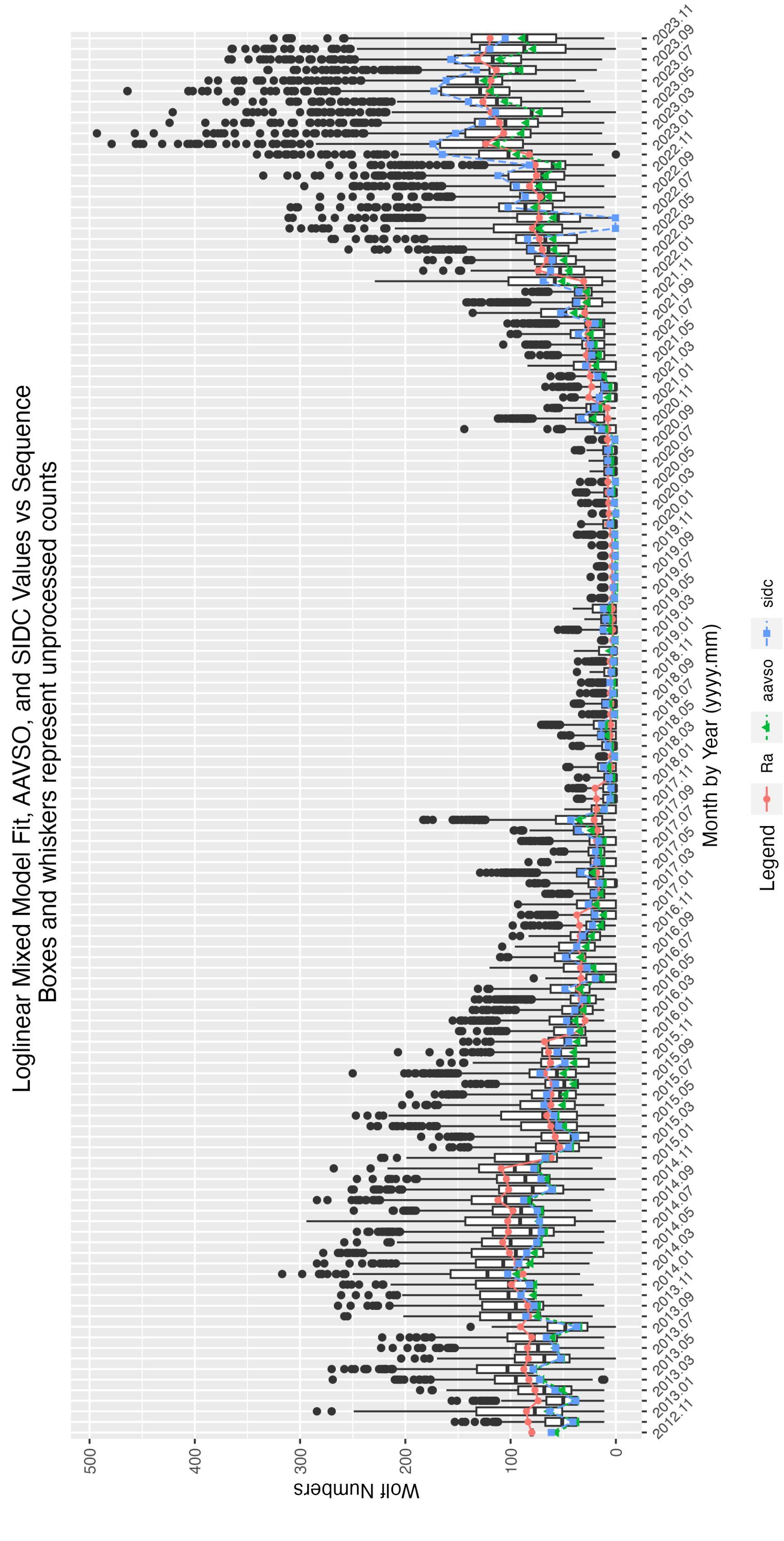

Figure 7: GLMM fitted data for R_a. AAVSO data: https://www.aavso.org/category/tags/solar-bulletin. SIDC data: WDC-SILSO, Royal Observatory of Belgium, Brussels.

4 Endnotes

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

4.1 Antique telescope project

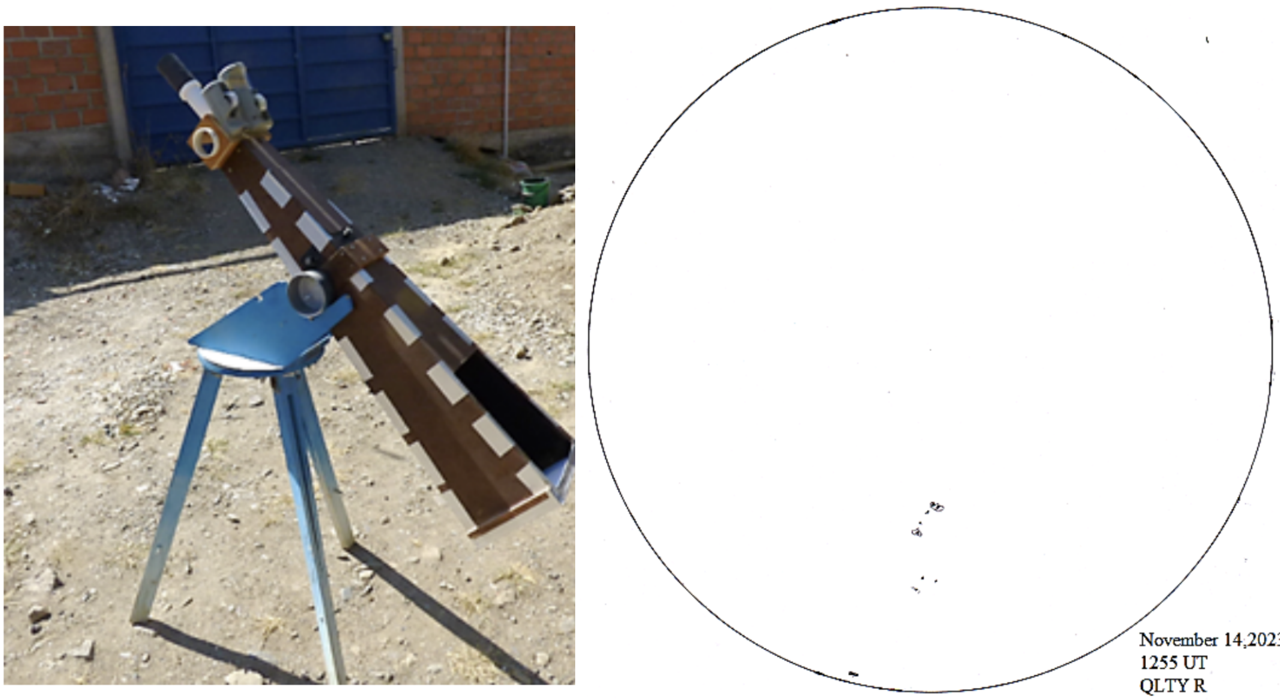

Figure 8: An antique telescope built by Gonzalo Vargas (BZX) (left). Drawing for the 14th of November, from Cochabamba, Bolivia (right).

5 References

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