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 1. The relative sunspot numbers are in Section 2. Section 3 has endnotes.

OH absorption thru interstellar medium when looking at the center of the galaxy (Sgr A*) with a radio telescope (https://www.aavso.org/tags/radio)

The objective of this study will be to detect OH absorption signatures when looking at the center of the galaxy (Sgr A*) Ra 18.34, Dec -29, or close to M22 at 18.36, Dec -24. Determine which of the 3 Hydroxyl radio frequencies at 18 cm has most absorption characteristics. Comparison measure of the frequencies between two test statistics is shown in the results. Detection of OH frequencies for absorption of the intervening galactic clouds using Sgr A* as a bright radio source. Detection of the OH absorption at 1612GHz, 1.665GHz and 1.667GHz, in the interstellar medium has been studied since (1963, S.Weinreb et al) where OH absorption between SgrA* and Earth. This work is important for several reasons. (1) It will generate scientifically interesting data obtained by Astropeiler. (2) It will provide preliminary and detailed data that will be used in future observations of other interstellar absorption at different OH frequencies. `https://www.astropeiler.de` 25 meter telescope was able to observe OH frequencies (OH1612, OH1665 and OH1667) looking at the center of the galaxy in August 2023.

"We have squeezed in a short observation of OH absorption towards the galactic center in today's schedule as a feasibility study. Thanks to Thomas who did the telescope operation this evening to support this. The result is that we do see very clearly the absorption on the OH1667 and OH1665 lines with the telescope pointing at the galactic center. The results are preliminary and additional measurements will be necessary to refine baseline corrections. Also, the intensities are uncalibrated. I have attached a spectrum of OH1667 and OH1665 each and a comparison of both in a combined plot. In the combined plot the black line is the spectrum from OH1667 absorption, the red line is from OH 1665. Comparison with the paper by Robinson and McGee shows that we are seeing what can be expected."

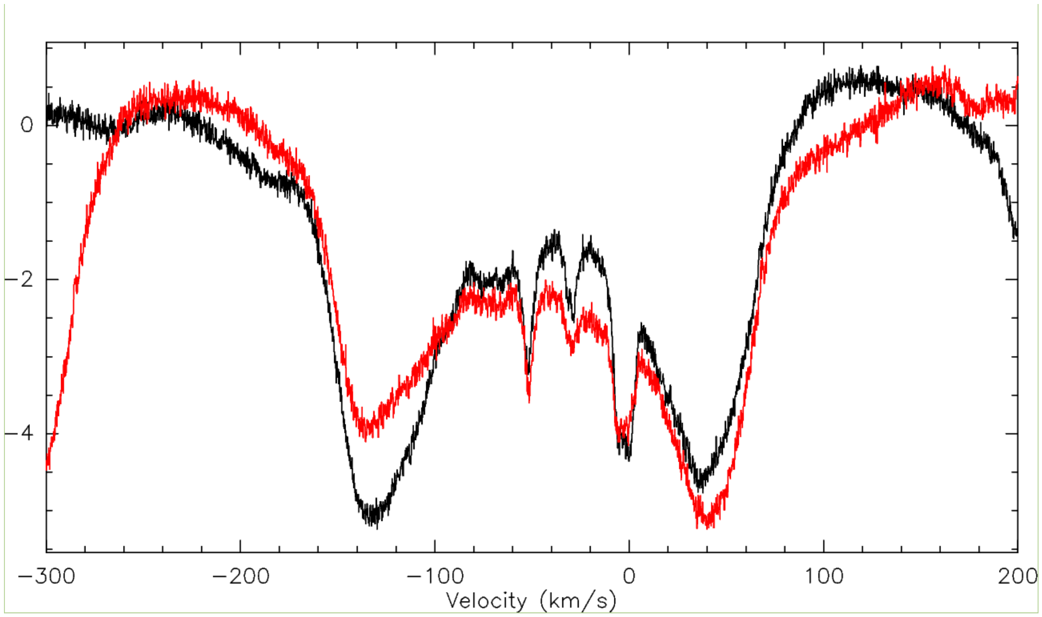

Figure 1: An OH "cloud" of total variation split velocity measures for OH1665 (red) and OH1667 (black) . We're looking at the center of the galaxy as it rotates; positive velocities are going away from us, and negative velocities are coming toward us. Notice there are many absorption lines coming toward us, up to 100 km/second.

REFERENCES

1963 S.Weinreb et al. Radio observations of OH in the interstellar medium Nature, November 30, 1963, No 4909. Observation of OH Absorption Lines in the Radio Spectrum of the Galactic Centre Bolton et. al., Nature 201, page 279 (1964) `https://www.nature.com/articles/201279a0.pdf?origin=ppub`

OH absorption at 1667 MHz near the galactic center Robinson, McGee, Aust. J. Phys. 23 405-423 (1970) `https://adsabs.harvard.edu/full/1970AuJPh..23..405R`

Aperture Synthesis of 1667 MHz OH Absorption in the Direction of the Galactic Center J-H. Bieging, Astron. Astroph. 51 289-302 (1976) `https://ui.adsabs.harvard.edu/abs/1976A%26A....51..289B/abstract`

18-cm VLA observations of OH towards the Galactic Centre Karlsson et. al. , A and A 403, 10111021 (2003) `https://www.aanda.org/articles/aa/pdf/2003/21/aa2882.pdf`

The OH-streamer in Sagittarius A revisited: analysis of hydroxylabsorption within 10 pc from the Galactic centreKarlsson et. al. , A and A 582, A118 (2015) `https://ui.adsabs.harvard.edu/abs/2015A%26A...582A.118K/abstract`

1 Sudden Ionospheric Disturbance (SID) Report

1.1 SID Records

April 2026 (Figure 2): there were 2 M-class, and 15 C-class flares on the 28th of April showing 5 SID events during the day; This VLF scan was recorded in southern France by Lionel Laudet (A118). (U.S. Dept. of Commerce–NOAA, 2022).

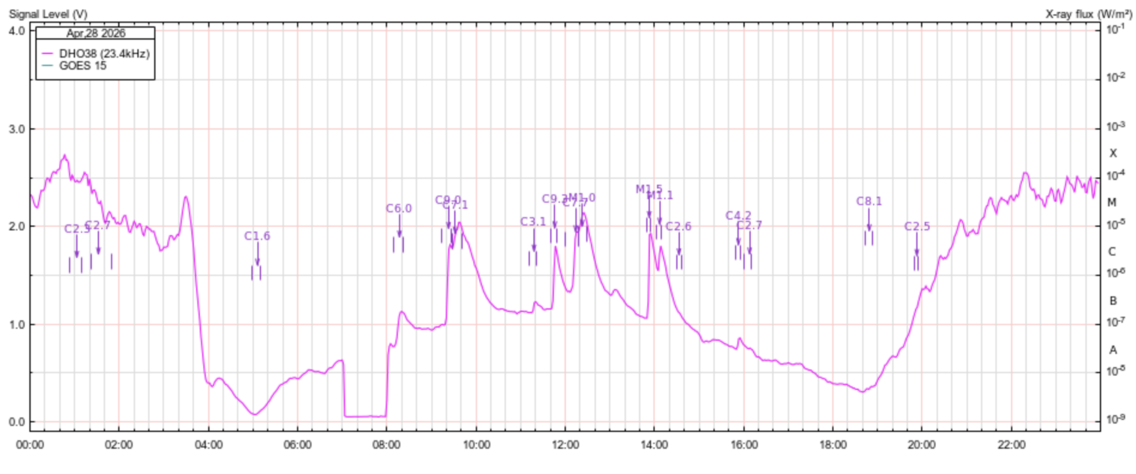

Figure 2: VLF recording from Southern France.

1.2 SID Observers

In April 2026 we had 8 AAVSO SID observers who submitted VLF data, as listed in Table 1.

Table 1: 202604 VLF Observers

Observer	Code	Stations
R Battaiola	A96	ICV
L Loudet	A118	DHO GBZ
J Godet	A119	DHO GBZ GQD
R Mrllak	A136	NSY
S Aguirre	A138	NPM
L Pina	A148	NAA NML
J Wendler	A150	NAA
J DeVries	A153	NLK

Figure 8 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.

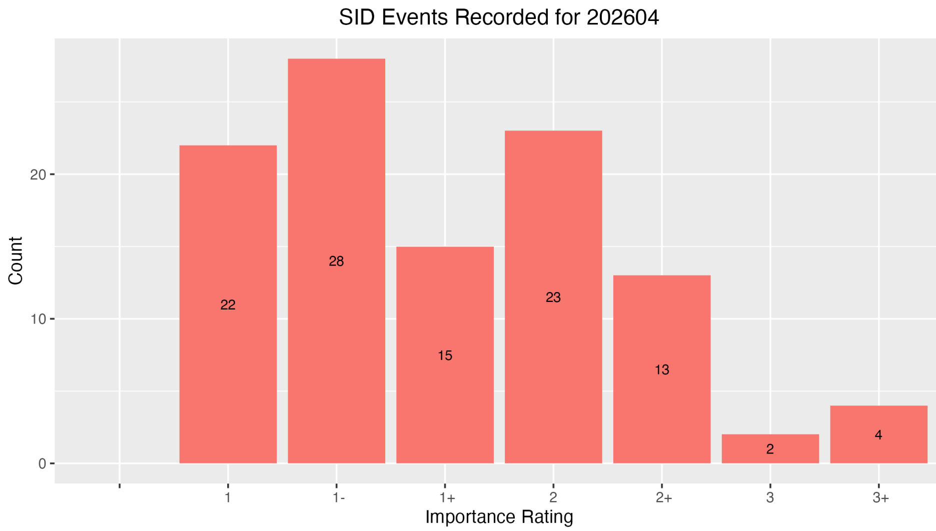

Figure 3: VLF SID Events.

1.3 Solar Flare Summary from GOES-16 Data

In April 2026, there were 346 GOES-19 XRA flares: two X-class, 27 M-class, 220 C-class, and 97 B-class flares. Far more flaring this month compared to last. (see Figure 4).

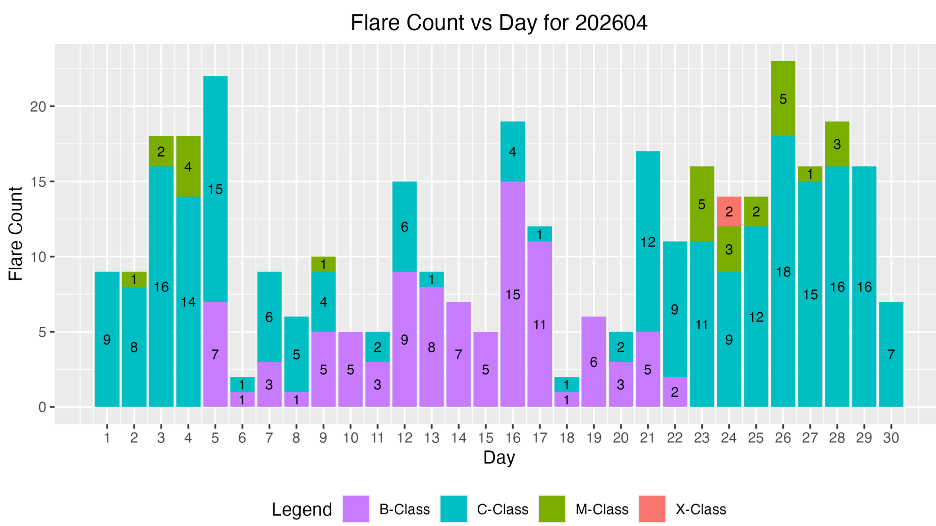

Figure 4: GOES-19 XRA flares (U.S. Dept. of Commerce–NOAA, 2023).

2 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.

2.1 Raw Sunspot Counts

The raw daily sunspot counts consist of submitted counts from all observers who provided data in April 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. All observers whose submissions qualify through this month's scrubbing process are represented in Figure 5.

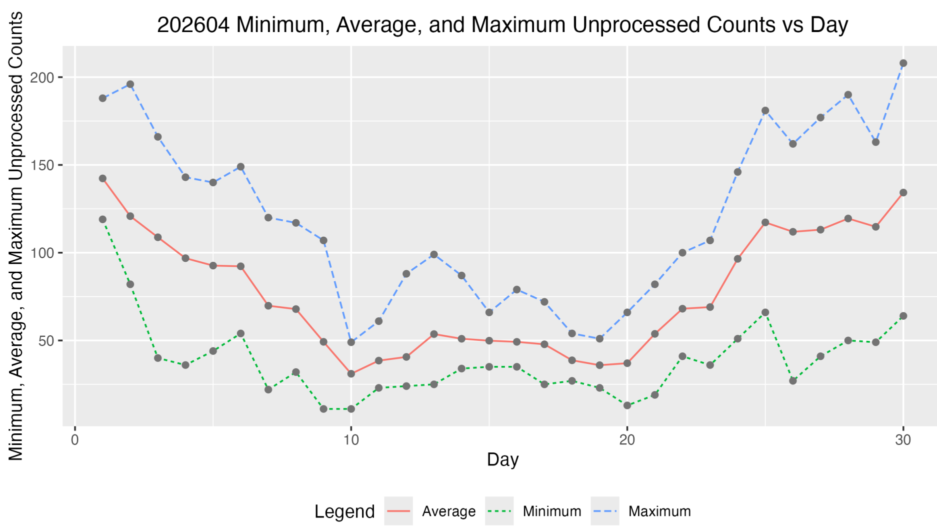

Figure 5: Raw Wolf number average, minimum and maximum by day of the month for all observers.

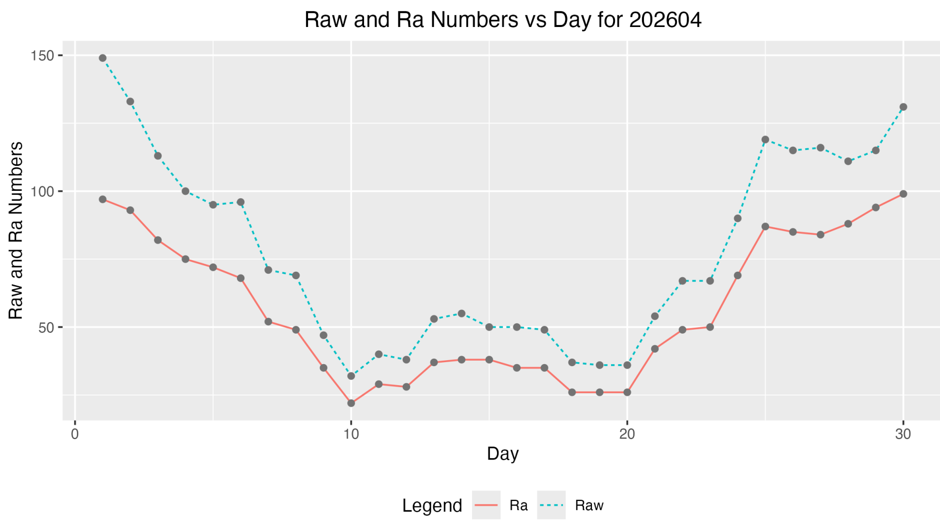

Figure 6: Raw Wolf average and R_a numbers by day of the month for all observers.

2.2 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: 202604 American Relative Sunspot Numbers (R_a).

Day	Number of Observers	Raw	R_a
1	25	149	97
2	28	133	93
3	37	113	82
4	40	100	75
5	34	95	72
6	35	96	68
7	37	71	52
8	41	69	49
9	35	47	35
10	31	32	22
11	38	40	29
12	24	38	28
13	25	53	37
14	33	55	38
15	34	50	38
16	32	50	35

Continued

Table 2: 202604 American Relative Sunspot Numbers (R_a).

Day	Number of Observers	Raw	R_a
17	39	49	35
18	31	37	26
19	39	36	26
20	39	36	26
21	35	54	42
22	31	67	49
23	38	67	50
24	41	90	69
25	34	119	87
26	32	115	85
27	35	116	84
28	33	111	88
29	32	115	94
30	31	131	99
Averages	34	77.8	57

2.3 Sunspot Observers

Table 3 lists the Observer Code (column 1), the Number of Observations (column 2) submitted for April 2026, and the Observer Name (column 3). The final row gives the total number of observers who submitted sunspot counts (60), and total number of observations submitted (1019).

Table 3: 202604 Number of observations by observer.

Observer Code	Number of Observations	Observer Name
AAX	26	Alexandre Amorim
AJV	20	J. Alonso
ARAG	28	Gema Araujo
BATR	6	Roberto Battaiola
BKL	14	John A. Blackwell
BMIG	27	Michel Besson
BVZ	23	Jesus E. Blanco
BXZ	27	Jose Alberto Berdejo
BZX	19	A. Gonzalo Vargas
CIOA	1	Ioannis Chouinavas
CKB	19	Brian Cudnik
CMAB	8	Maurizio Cervoni
CNT	27	Dean Chantiles
CWD	5	David Cowall
DARB	22	Aritra Das
DFR	11	Frank Dempsey

Continued

Table 3: 202604 Number of observations by observer.

Observer Code	Number of Observations	Observer Name
DGIA	8	Giuseppe di Tommasco
DIL	17	Bill Dillon
DJOB	11	Jorge del Rosario
DJSA	7	Jeff DeVries
DJVA	25	Jacques van Delft
DMIB	28	Michel Deconinck
DPAL	10	Pacal Dabrowski
DUBF	26	Franky Dubois
EHOA	26	Howard Eskildsen
FALB	12	Allen Frohardt
FERA	25	Eric Fabrigat
GCNA	4	Candido Gomez
HOWR	19	Rodney Howe
HRUT	24	Timothy Hrutkay
ILUB	10	Luigi Iapichino
JDAC	14	David Jackson
JGE	2	Gerardo Jimenez Lopez
JSI	8	Simon Jenner
KAMB	30	Amoli Kakkar
KAND	24	Kandilli Observatory
KAPJ	14	John Kaplan
KNJS	23	James & Shirley Knight
KTOC	15	Tom Karnuta
LLEC	26	Leroy Leonard
LRRA	18	Robert Little
MARC	1	Arnaud Mengus
MARE	14	Enrico Mariani
MJHA	27	John McCammon
MMI	30	Michael Moeller
MUDG	5	George Mudry
MWMB	11	William McShan
MWU	25	Walter Maluf
PLUD	19	Ludovic Perbet
RJV	18	Javier Ruiz Fernandez
SDAW	10	David Scott
SDOH	30	Solar Dynamics Obs - HMI
SNE	8	Neil Simmons
SRIE	18	Rick St. Hilaire
TDE	22	David Teske
TPJB	3	Patrick Thibault
TST	22	Steven Toothman
URBP	30	Piotr Urbanski
WGI	10	Guido Wollenhaupt

Continued

Table 3: 202604 Number of observations by observer.

Observer Code	Number of Observations	Observer Name
YAAA	7	Anam Yargatti
Totals	1019	60

2.4 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 2 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.

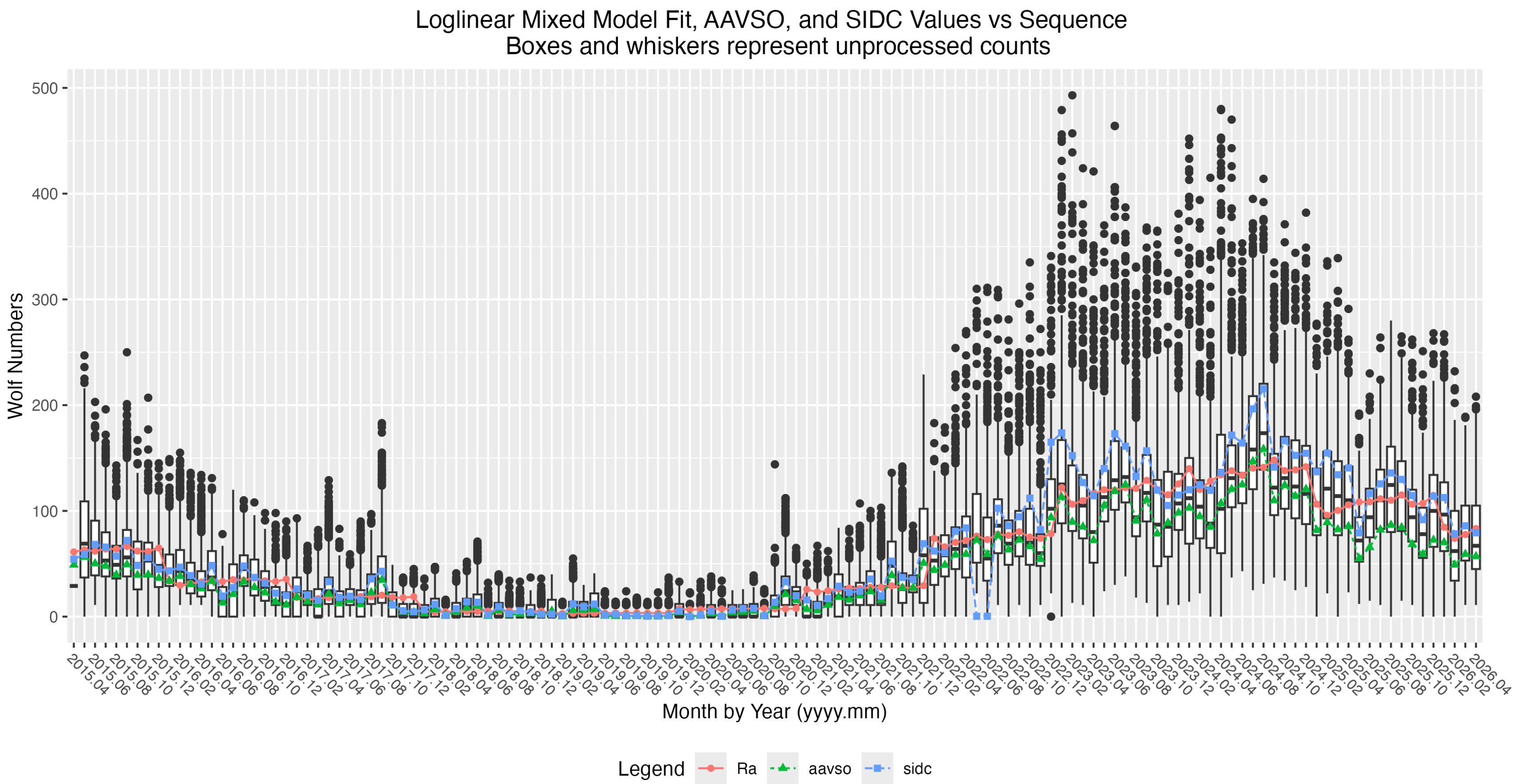

Figure 7: GLMM fitted data for R_a. AAVSO data: https://www.aavso.org/category/tags/solar-bulletin. SIDC data: WDC-SILSO, Royal Observatory of Belgium, Brussels

3 Endnotes

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

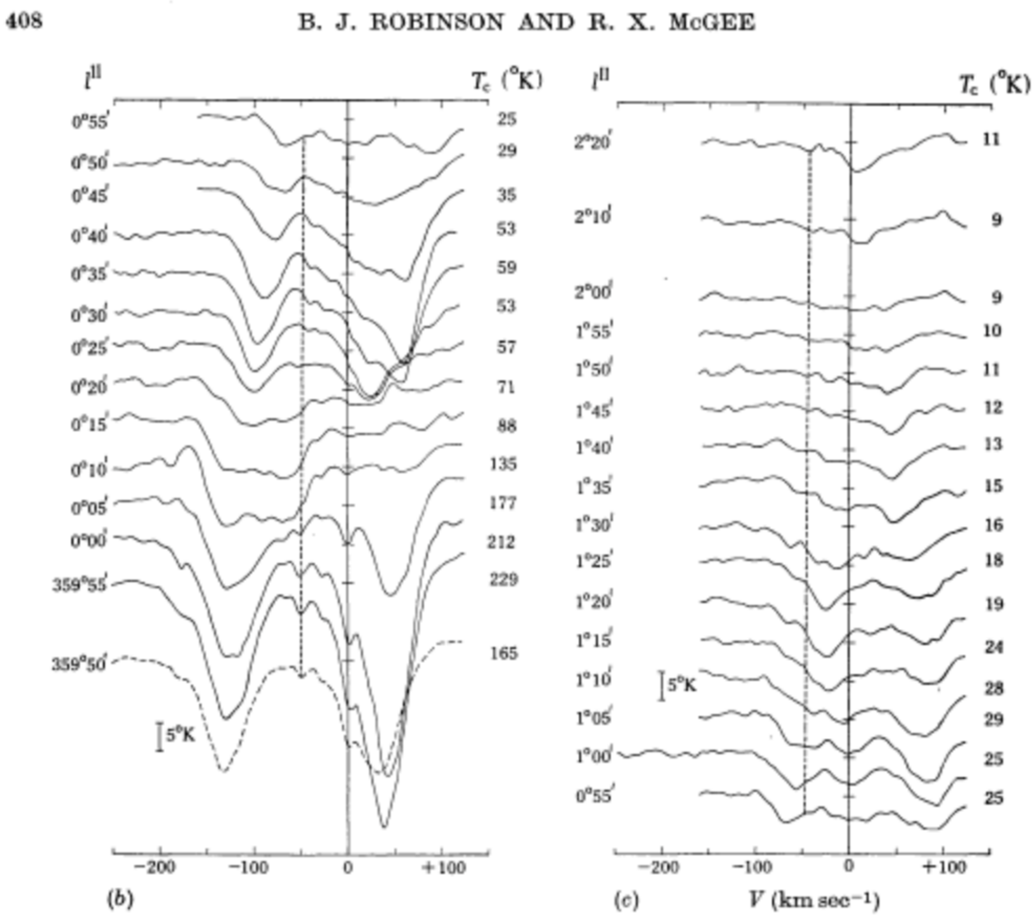

Figure 8: OH absorption at 1667 MHz near the galactic center Robinson, McGee, Aust. J. Phys. 23 405-423 (1970) `https://adsabs.harvard.edu/full/1970AuJPh..23..405R`.

4 Antique telescope project

Figure 9: A recent replica of an antique telescope built by Gonzalo Vargas (BZX) in Cochabamba, Bolivia (left), and a drawing for the 28th of April with 2 M class flares (right).

5 References

Dr. Jamie Riggs, Solar System Science Section Head, International Astrostatistics R Statistical Software (2023), TSA Libraries: `https://cran.r-project.org`

SIDC data (2023), WDC-SILSO, Royal Observatory of Belgium, Brussels `https://www.sidc.be/silso/datafiles`

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