Solar Bulletin

THE AMERICAN ASSOCIATION OF VARIABLE STAR OBSERVERS
SOLAR SECTION

David Jackson, Kristine Larsen, Co-Chairs
c/o 1770 Massachusetts Ave Ste 121
Cambridge, MA 02140-2808

Web: https://www.aavso.org/solar-bulletin
Email: solar@aavso.org
ISSN 0271-8480

Volume 82 Number 3 March 2026

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.

March Madness, the Auroral Edition

The observed correlation between auroral activity and equinoxes is currently understood as largely related to the geometry between the earth's magnetic field and that of the solar wind, frequently termed the Russell-McPherron effect (Russell and McPherson 1973). A secondary geometrical alignment, the equinoctial effect, occurs twice a day near the equinoxes, placing the plane of the solar wind itself at 90 degrees to our magnetic poles (Young et al.).

While it is impossible to conclusively state who was the first person to notice this seasonal effect, the claim was certainly noted in scientific publications beginning more than a century ago.

For example, the increase in the incidence of geomagnetic disturbances around the equinoxes was discussed in detail in a 1911 paper by Rev. Aloysius Laurence Cortie (1859-1925), Director of the Stonyhurst College Observatory. Cortie is well-known for his observations of sunspots and solar eclipses and his published papers on the connection between sunspot activity and magnetic phenomenon (Turner 1926, 175).

Cortie in turn is quick to give credit to previous observations of this correlation, in particular a textbook by Charles Chree (1912, 189-90) and a paper by William Ellis (1905, 520). Ellis himself explains that he had tentatively noted the relationship in earlier works, in 1899 and 1901, but his 1905 paper includes detailed graphs of the Greenwich data from 1848-97, as shown below.

The two peaks in the smoothed data fall at approximately March 3 and October 9, several weeks before and after the vernal and autumnal equinoxes, respectively.

Cortie's paper extends the analysis, using data from 1889-1911 published by his predecessor at Stonyhurst, Rev. Walter Sidgreaves.

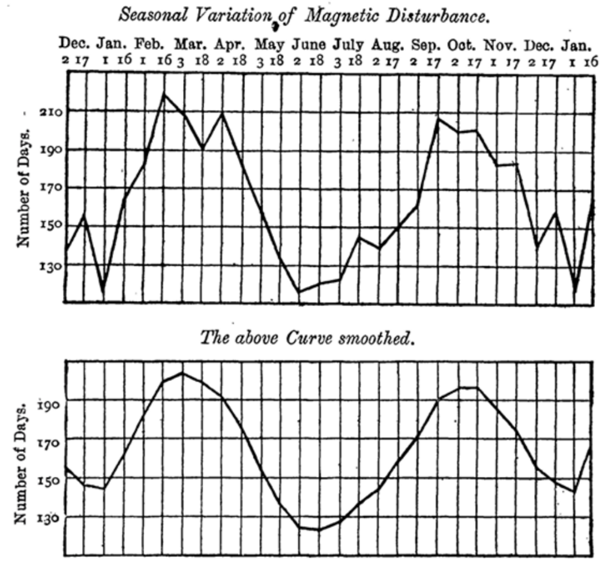

Figure 1: Ellis's seasonal pattern in geomagnetic disturbances (Ellis 1905, 522).

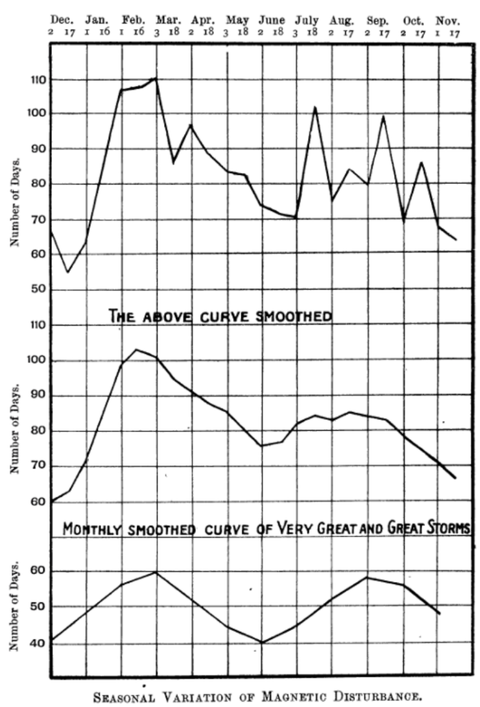

Figure 2: Cortie's seasonal pattern in geomagnetic disturbances (Cortie 1912, 57).

Cortie's smoothed data shows maxima in early March and September, in both cases several weeks before the equinoxes. Interestingly, Cortie's data suggests that the vernal equinox has a stronger effect than the autumnal one, although including only the strongest geomagnetic storms decreases the apparent difference in the data. A similar small difference is also noticeable in Ellis's graphs.

This slight difference is also noted in graphical analysis by David Hathaway, based on monthly-binned data from 1932-2007 (2024). So while both equinoxes are relatively favorable times for those wishing to cross observing aurora off their bucket list (especially in years near solar maximum), March has a slight edge, statistically speaking.

REFERENCES

Chree, C. Studies in Terrestrial Magnetism, Macmillan and Co., 1912. https://books.google.com/books/about/Studies_in_Terrestrial_Magnetism.html?id=5SqjFwh7rz4C

Cortie, A.L. Sun-spots and Terestrial Magnetic Phenomenon, 1898-1911: the Cause of the Annual Variation in Magnetic Disturbances. MNRAS 73(1912): 52-60)

Hathaway, D. Average Number of Geomagnetically Disturbed Days 1932-2007). Spaceweather, 1 Mar. 2024. https://www.spaceweather.com/archive.php?view=1&day=01&month=03&year=2024

Russell, C.T., and R.L McPherson. Semiannual Variation of Geomagnetic Activity. Journal of Geophysical Research 78(1973): 92-108. https://doi.org/10.1029/JA078i001p00092

Turner, H.H. The Rev. Aloysius Laurence Cortie, S.J. MNRAS 86(1926): 175-7.

Young, C. Alex et al. Russell-McPherson Effect Gives Us An Aurora Season. EarthSky, 3 March, 2026. https://earthsky.org/sun/aurora-season-auroras-equinox-connection/

1 Sudden Ionospheric Disturbance (SID) Report

1.1 SID Records

March 2026 (Figure 3): there was 1 M-class, and 3 C-class flares on the 13th of March showing 4 SID events during the day; This VLF scan was recorded in southern France by Lionel Laudet (A118). (U.S. Dept. of Commerce–NOAA, 2022).

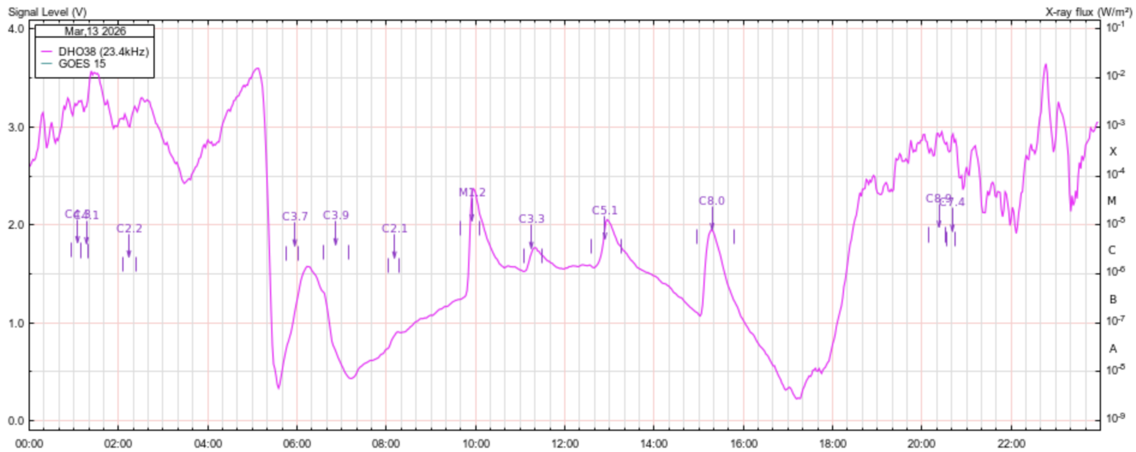

Figure 3: VLF recording from Southern France.

1.2 SID Observers

In March 2026 we had 10 AAVSO SID observers who submitted VLF data, as listed in Table 1.

Table 1: 202603 VLF Observers

Observer	Code	Stations
R Battaiola	A96	ICV
J Wallace	A97	NAA
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
H Krumnow	A152	DHO GBZ HWU
J DeVries	A153	NLK

Figure 4 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.

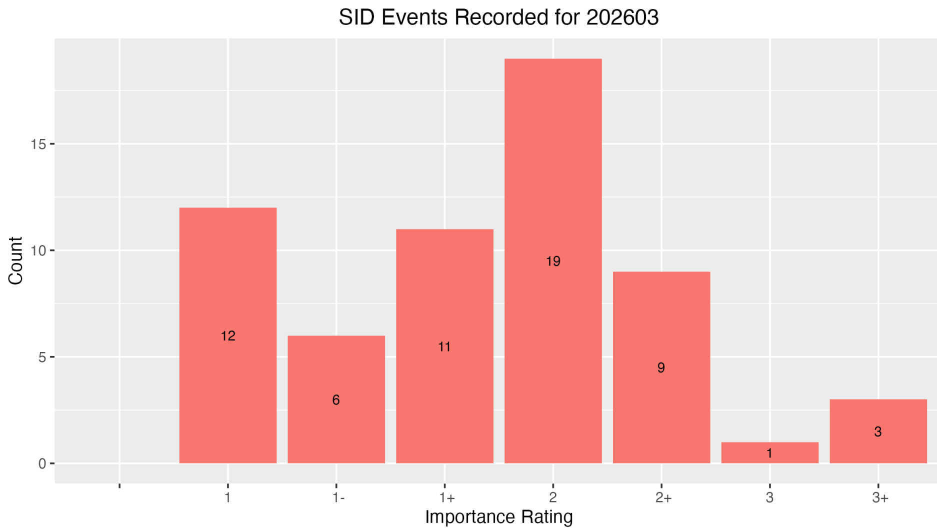

Figure 4: VLF SID Events.

1.3 Solar Flare Summary from GOES-16 Data

In March 2026, There were 229 GOES-19 XRA flares: one X class, 6 M class, 161 C class and 61 B class flares, Less flaring this month compared to last. (see Figure 5).

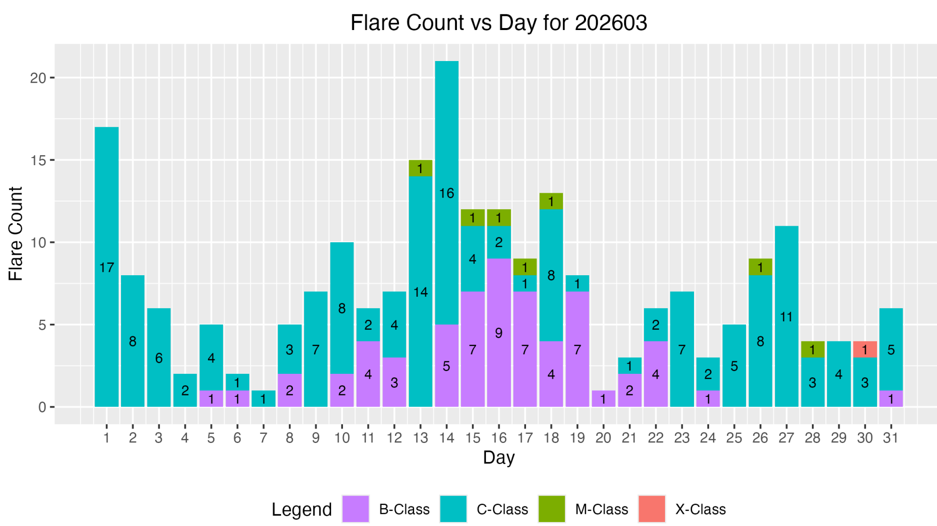

Figure 5: GOES-19 XRA flares (U.S. Dept. of Commerce–NOAA, 2023).

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 March 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 6.

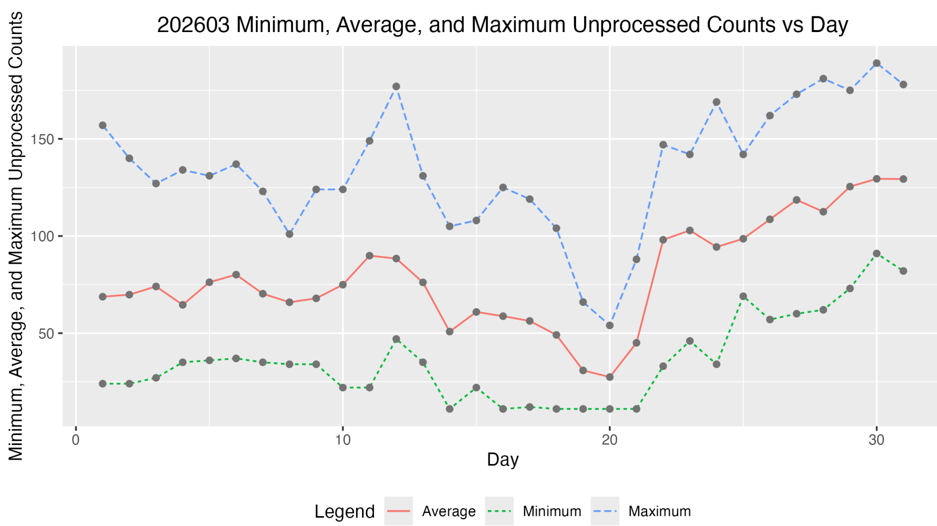

Figure 6: Raw Wolf number average, minimum and maximum by day of the month for all observers.

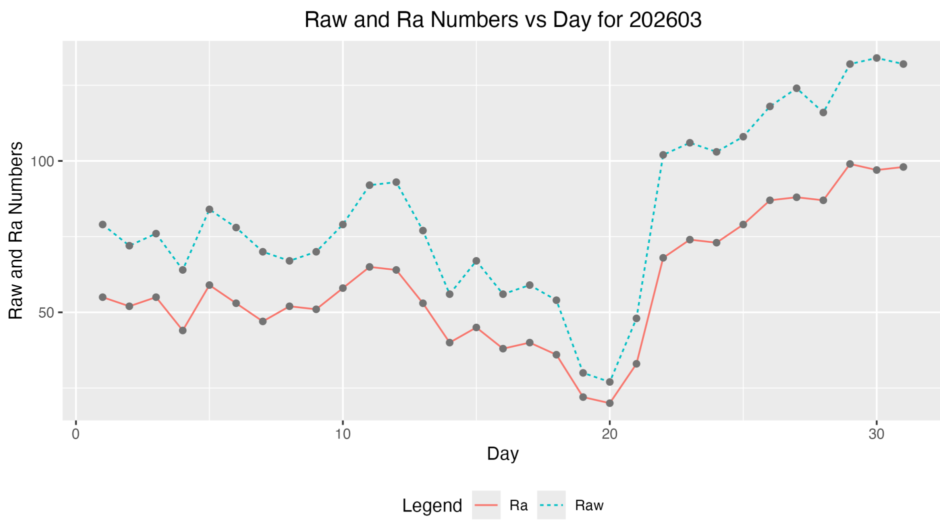

Figure 7: Raw Wolf average and R_a numbers by day of the month for all observers.

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 7, 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: 202603 American Relative Sunspot Numbers (R_a).

Day	Number of Observers	Raw	R_a
1	46	79	55
2	39	72	52
3	29	76	55
4	33	64	44
5	32	84	59
6	24	78	53
7	23	70	47
8	35	67	52
9	35	70	51
10	33	79	58
11	26	92	65
12	32	93	64
13	33	77	53
14	31	56	40
15	33	67	45
16	32	56	38

Continued

Table 2: 202603 American Relative Sunspot Numbers (R_a).

Day	Number of Observers	Raw	R_a
17	35	59	40
18	33	54	36
19	37	30	22
20	38	27	20
21	34	48	33
22	31	102	68
23	35	106	74
24	36	103	73
25	36	108	79
26	39	118	87
27	39	124	88
28	40	116	87
29	37	132	99
30	34	134	97
31	33	132	98
Averages	34	83	59.1

2.3 Sunspot Observers

Table 3 lists the Observer Code (column 1), the Number of Observations (column 2) submitted for March 2026, and the Observer Name (column 3). The final row gives the total number of observers who submitted sunspot counts (61), and total number of observations submitted (1053).

Table 3: 202603 Number of observations by observer.

Observer Code	Number of Observations	Observer Name
AAX	26	Alexandre Amorim
AJV	21	J. Alonso
ARAG	30	Gema Araujo
ASA	2	Salvador Aguirre
BATR	7	Roberto Battaiola
BKL	10	John A. Blackwell
BMIG	27	Michel Besson
BTB	9	Thomas Bretl
BVZ	16	Jesus E. Blanco
BXZ	25	Jose Alberto Berdejo
BZX	18	A. Gonzalo Vargas
CKB	28	Brian Cudnik
CMAB	3	Maurizio Cervoni
CNT	30	Dean Chantiles
CWD	6	David Cowall

Continued

Table 3: 202603 Number of observations by observer.

Observer Code	Number of Observations	Observer Name
DARB	28	Aritra Das
DFR	9	Frank Dempsey
DGIA	6	Giuseppe di Tommasco
DIL	24	Bill Dillon
DJOB	14	Jorge del Rosario
DJSA	10	Jeff DeVries
DJVA	30	Jacques van Delft
DMIB	27	Michel Deconinck
DUBF	27	Franky Dubois
EHOA	27	Howard Eskildsen
FALB	24	Allen Frohardt
FERA	17	Eric Fabrigat
GCNA	6	Candido Gomez
GIGA	23	Igor Grageda Mendez
HKY	18	Kim Hay
HOWR	17	Rodney Howe
HRUT	28	Timothy Hrutkay
ILUB	10	Luigi Iapichino
JDAC	9	David Jackson
JSI	5	Simon Jenner
KAMB	31	Amoli Kakkar
KAND	13	Kandilli Observatory
KAPJ	20	John Kaplan
KNJS	29	James & Shirley Knight
KTOC	9	Tom Karnuta
LKR	3	Kristine Larsen
LLEC	26	Leroy Leonard
LRRA	18	Robert Little
MARC	2	Arnaud Mengus
MARE	14	Enrico Mariani
MJHA	28	John McCammon
MMI	31	Michael Moeller
MUDG	7	George Mudry
MWMB	18	William McShan
MWU	18	Walter Maluf
PLUD	13	Ludovic Perbet
RJV	17	Javier Ruiz Fernandez
SDOH	31	Solar Dynamics Obs - HMI
SNE	9	Neil Simmons
SRIE	8	Rick St. Hilaire
TDE	27	David Teske
TPJB	1	Patrick Thibault
TST	17	Steven Toothman

Continued

Table 3: 202603 Number of observations by observer.

Observer Code	Number of Observations	Observer Name
URBP	28	Piotr Urbanski
WGI	3	Guido Wollenhaupt
YAAA	15	Anam Yargatti
Totals	1053	61

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 8 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.

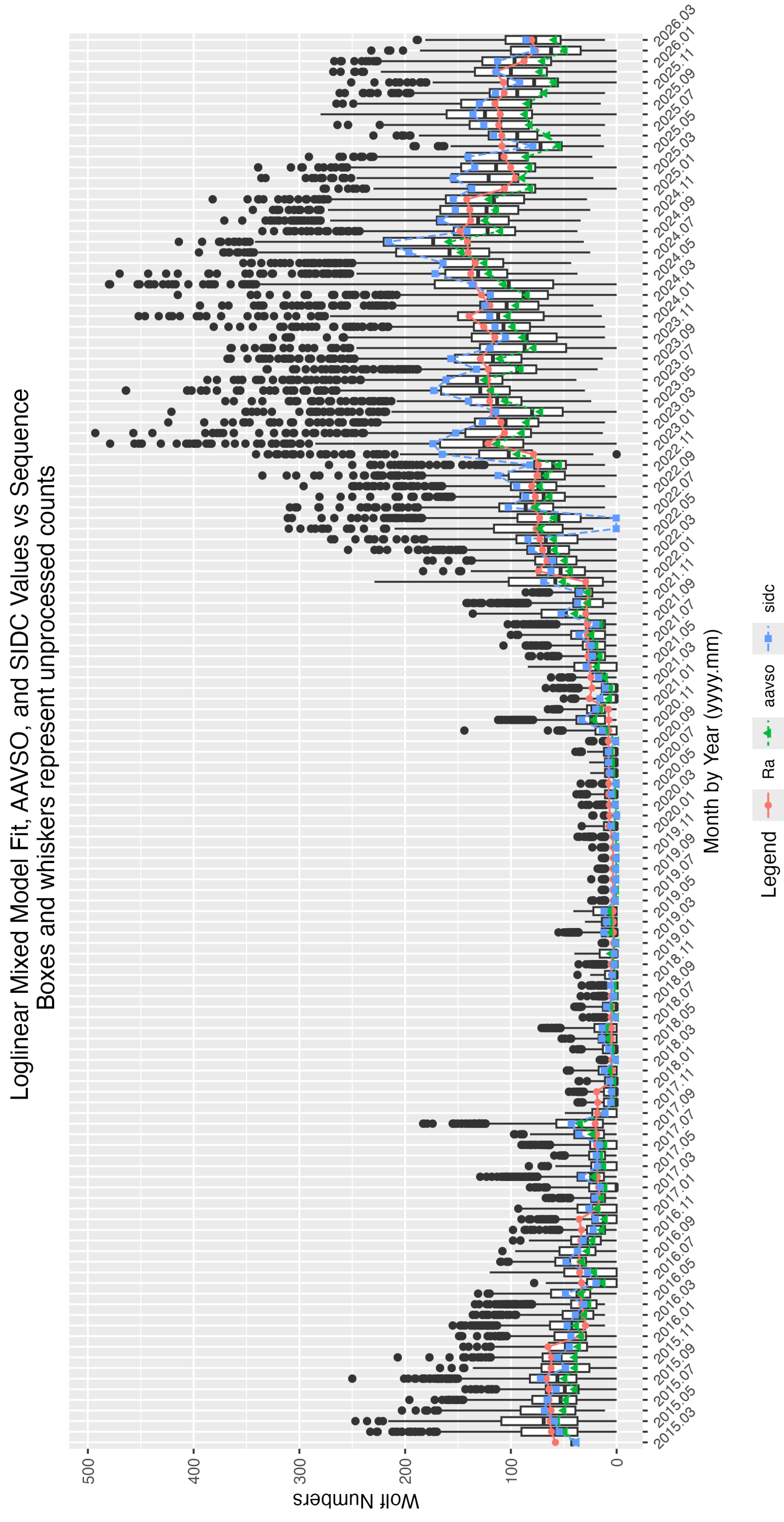

Figure 8: GLMM fitted data for R_a. AAVSO data: https://www.aavso.org/category/tags/solar-bulletin. SIDC data: WDC-SILSO, Royal Observatory of Belgium, Brussels

3 Endnotes

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

4 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/`