Solar Bulletin

THE AMERICAN ASSOCIATION OF VARIABLE STAR OBSERVERS
SOLAR SECTION

Rodney Howe, Editor, Chair
c/o AAVSO, 49 Bay State Rd
Cambridge, MA 02138 USA

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

Volume 75 Number 1 January 2019

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. Section 1 gives contributions by our members. The sudden ionospheric disturbance report is in Section 2. The relative sunspot numbers are in Section 3. Section 4 has endnotes.

1 Solar scopes are cool in Choice course 101.

Figure 1: NEW Observing and counting sunspots Choice course with Raffaello Braga (right)

Registration for the new choice course: (`https://www.aavso.org/choice-course-descriptions`)

For centuries after the first telescopic drawings of the Sun were made, observing and counting sunspots remained, and still is, one of the most important methods for monitoring the activity of our nearest star. This two week course will provide the fundamentals of visually observing, monitoring, and recording sunspots, with the aim of involving participants in the determination of the American Relative Sunspot Number R_a, a simple and effective index of the solar photospheric activity. It has been recorded by AAVSO since 1944 with the purpose of maintaining a long-running and consistent database for the use of solar researchers world-wide. The course will focus on several topics such as equipment, safety issues, basic concepts about sunspot activity, morphology of sunspots and sunspot groups, and recording and reporting observations. Counting sunspots requires some basic knowledge on how sunspot groups appear, develop, and decay, thus, some time will be devoted to sunspot groups classification.

The course will consider only white light observations of the Sun. They can be carried out with only a very modest telescope and a commercial solar filter and do not require any expensive equipment. Narrowband (e.g. H-alpha) observing and imaging are outside the scope of the course.

There are no prerequisites for participating. The course is open to everybody, even to absolute beginners in solar observing. However, more experienced observers may be interested to join for discussing in detail some of the topics and for contributing to the course with their own experience.

The AAVSO Solar Observing Guide will be used as the reference text. (`https://www.aavso.org/solar-observing-guide`) Don't forget to register!

2 Sudden Ionospheric Disturbance (SID) Report

2.1 SID Records

January 2019 (Figure 2): There was a C5 class flare on the 26th of January recorded here Fort Collins, Colorado. However, it was during the sunrise terminator where it is difficult to detect SID event flares in the ionosphere. (Please note the y-axis values in these SID graphs are non-dimensional.)

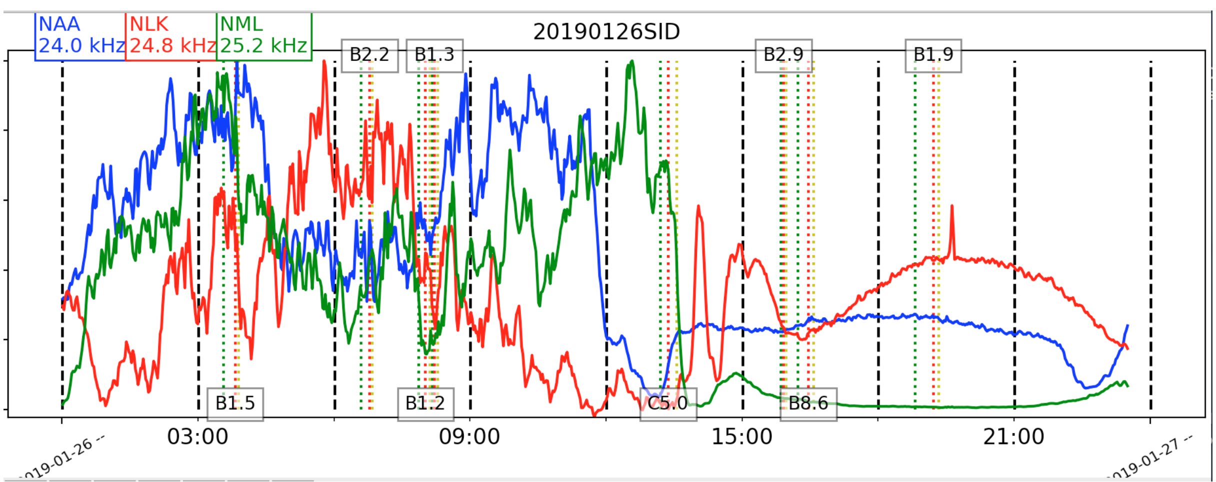

Figure 2: VLF recording at Fort Collins, Colorado.

2.2 SID Observers

In January 2019 we had 19 AAVSO SID observers who submitted VLF data as listed in Table 1. There were a few European observers who recorded the C5 SID event on the 26th this month.

Table 1: 201901 VLF Observers

Observer	Code	Stations
S Hansen	A59	NAA
A McWilliams	A94	NML
R Battaiola	A96	HWU
J Wallace	A97	NAA
L Loudet	A118	DHO GBZ
J Godet	A119	GBZ
B Terrill	A120	NWC
F Adamson	A122	NAA
G Meyers	A124	NPM
S Oatney	A125	NML NLK NAA
J Karlovsky	A131	NSY ICV
R Green	A134	NWC
R Mrllak	A136	NSY GQD
S Aguirre	A138	NPM
I Ryumshin	A142	GQD DHO
R Rogge	A143	GQD
K Menzies	A146	NAA
R Russel	A147	NPM
L Ferreira	A149	NWC

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.

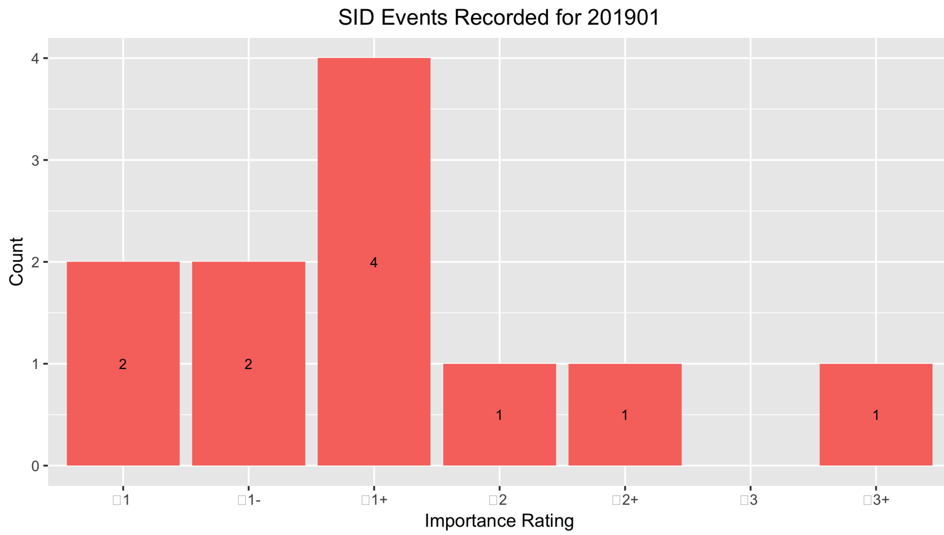

Figure 3: VLF SID Events.

2.3 Solar Flare Summary from GOES-15 Data

In January 2019, there were 57 flares reported by GOES-15 this month. Far more flaring than last month: Two A class, 49 B class and 6 C class flares. Quite the start of the new year! There were 16 days this month with no GOES-15 reports of flares. (see Figure 4).

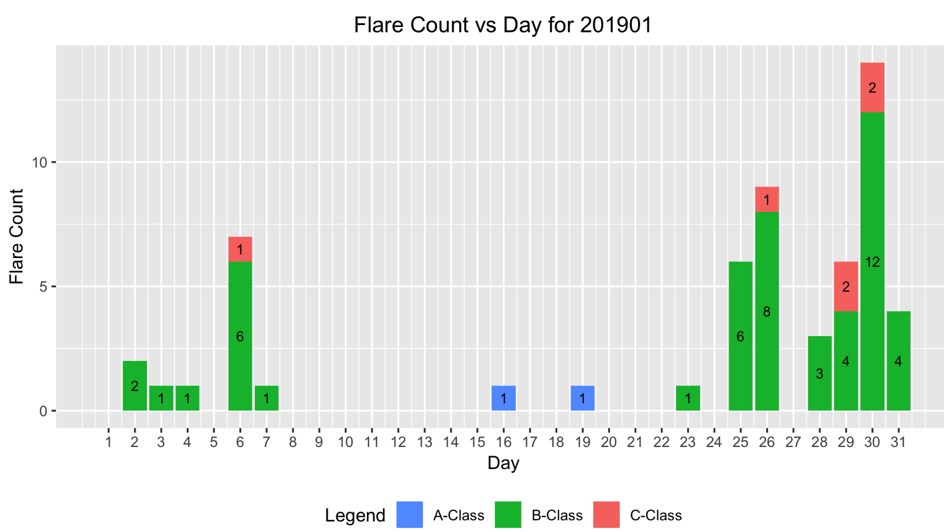

Figure 4: GOES - 15 XRA flares

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 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 January 2019. These counts are reported by the day of the month, and are either from data not scrubbed or corrected data.

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.

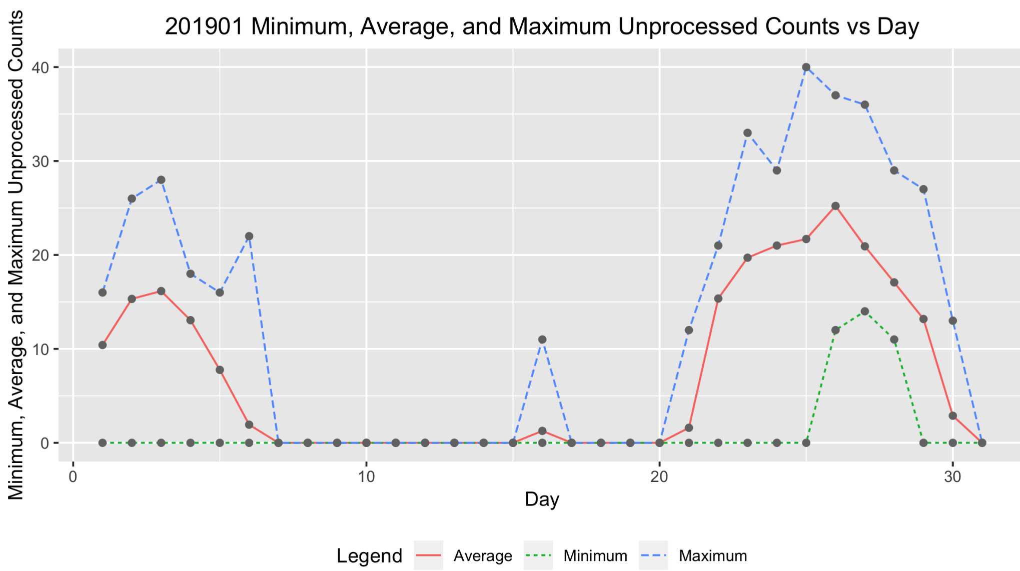

Figure 5: Raw Wolf number average, minimum and maximum by day of the month for all observers.

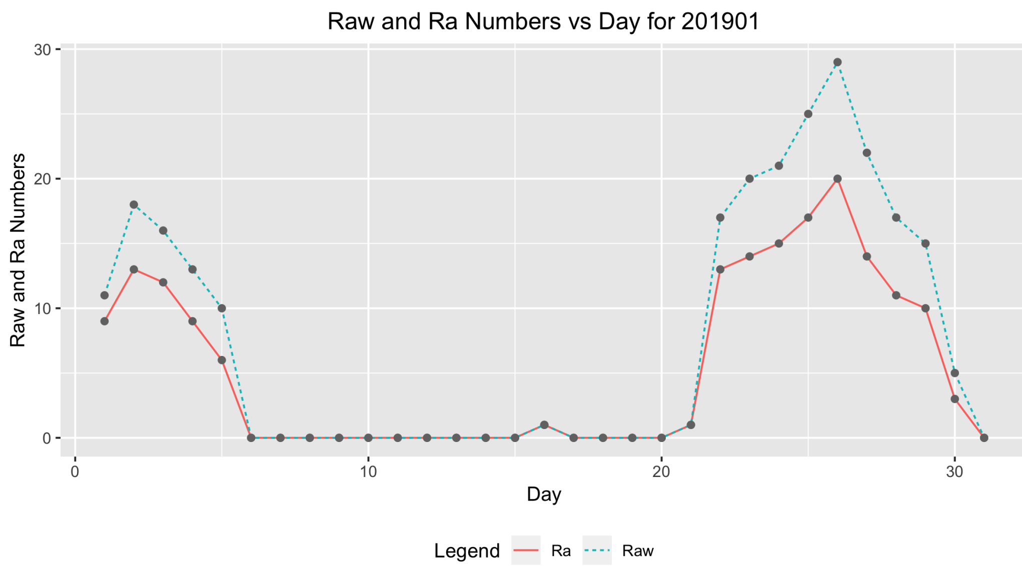

Figure 6: Raw Wolf average and R_a numbers by day of the month for all observers.

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 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 (column 1) of the observation, the Number of Observations is in column 2, the raw Wolf number is in column 3, and the Shapley correction (R_a) is in column 4.

Table 2: 201901 American Relative Sunspot Numbers (R_a).

Day	Number of Observers	Raw	R_a
1	34	11	9
2	28	18	13
3	32	16	12
4	36	13	9
5	34	10	6
6	29	0	0
7	31	0	0
8	30	0	0
9	33	0	0
10	29	0	0
11	30	0	0
12	26	0	0
13	36	0	0
14	36	0	0
15	25	0	0

Continued

Table 2: 201901 American Relative Sunspot Numbers (R_a).

Day	Number of Observers	Raw	R_a
16	26	1	1
17	29	0	0
18	26	0	0
19	32	0	0
20	35	0	0
21	35	1	1
22	25	17	13
23	24	20	14
24	30	21	15
25	39	25	17
26	41	29	20
27	36	22	14
28	38	17	11
29	33	15	10
30	34	5	3
31	24	0	0
Averages	31.5	7.8	5.4

3.3 Sunspot Observers

Table 3 lists the Observer Code (column 1), the Number of Observations (column 2) submitted for January 2019, and the Observer Name (column 3). The final rows of the table give the total number of observers who submitted sunspot counts and the total number of observations submitted. The total number of observers is 64 and the total number of observations is 976.

Table 3: 201901 Number of observations by observer.

Observer Code	Number of Observers	Observer Name
AAX	22	Alexandre Amorim
AJV	16	J. Alonso
ARAG	31	Gema Araujo
ASA	21	Salvador Aguirre
ATE	15	Teofilo Arranz Heras
BARH	12	Howard Barnes
BATR	5	Roberto Battaiola
BERJ	26	Jose Alberto Berdejo
BMF	20	Michael Boschat
BRAD	27	David Branchett
BRAF	9	Raffaello Braga
BROB	19	Robert Brown
BSAB	18	Santanu Basu
CHAG	25	German Morales Chavez

Continued

Table 3: 201901 Number of observations by observer.

Observer Code	Number of Observers	Observer Name
CIOA	3	Ioannis Chouinavas
CKB	18	Brian Cudnik
CNT	18	Dean Chantiles
CVJ	9	Jose Carvajal
DEMF	6	Frank Dempsey
DIVA	11	Ivo Demeulenaere
DJOB	8	Jorge del Rosario
DMIB	23	Michel Deconinck
DUBF	16	Franky Dubois
EHOA	25	Howard Eskildsen
ERB	7	Bob Eramia
FERJ	14	Javier Ruiz Fernandez
FLET	21	Tom Fleming
FLF	11	Fredirico Luiz Funari
FTAA	3	Tadeusz Figiel
HAYK	11	Kim Hay
HOWR	23	Rodney Howe
HRUT	20	Timothy Hrutkay
JDAC	6	David Jackson
JGE	4	Gerardo Jimenez Lopez
JPG	1	Penko Jordanov
KAND	12	Kandilli Observatory
KAPJ	18	John Kaplan
KNJS	31	James & Shirley Knight
KROL	21	Larry Krozel
LEVM	17	Monty Leventhal
LKR	3	Kristine Larsen
LRRA	9	Robert Little
MARE	7	Enrico Mariani
MCE	27	Etsuiku Mochizuki
MILJ	12	Jay Miller
MJAF	31	Juan Antonio Moreno Quesada
MJHA	29	John McCammon
MUDG	6	George Mudry
MWU	23	Walter Maluf
OAAA	28	Al Sadeem Astronomy Observatory
OATS	1	Susan Oatney
ONJ	4	John O'Neill
SDOH	31	Solar Dynamics Obs - HMI
SMNA	3	Michael Stephanou
SNE	3	Neil Simmons
SONA	6	Andries Son
STAB	23	Brian Gordon-States

Continued

Table 3: 201901 Number of observations by observer.

Observer Code	Number of Observers	Observer Name
SUZM	28	Miyoshi Suzuki
TESD	20	David Teske
TPJB	3	Patrick Thibault
TST	2	Steven Toothman
VARG	26	A. Gonzalo Vargas
VIDD	13	Daniel Vidican
WILW	15	William M. Wilson
Totals	976	64

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 a paper (GLMM05) on http://www.spesi.org/?page_id=65 of the sunspot counts research page. The paper title is *A Generalized Linear Mixed Model for Enumerated Sunspots.*

Figure 7 shows the monthly GLMM R_a numbers for the 24th solar cycle to date. 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 confidence band uses the large sample approximation based on the Gaussian distribution. 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.

4 Endnotes

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

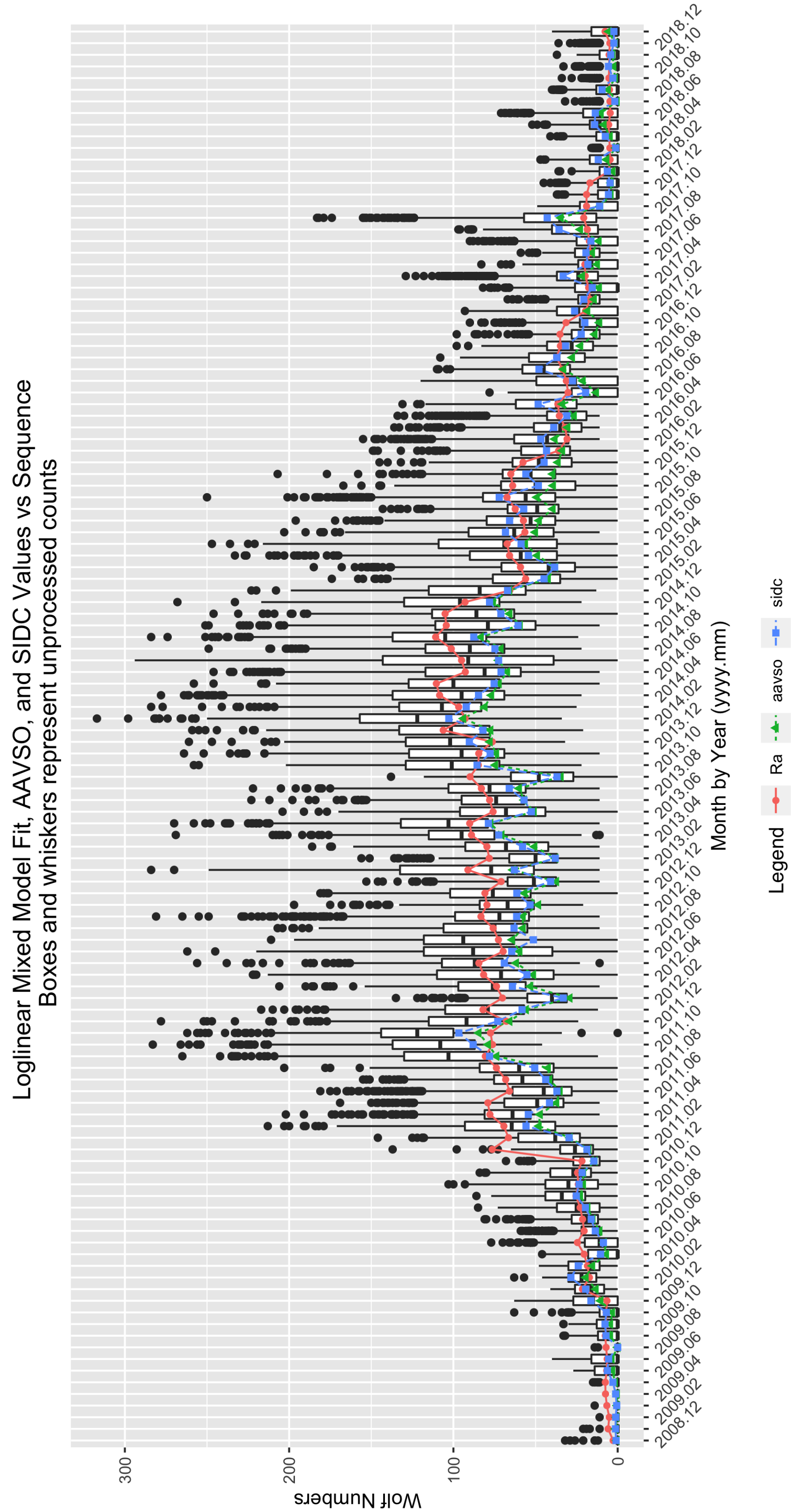

Figure 7: GLMM fitted data for R_a. AAVSO data: https://www.aavso.org/category/tags/solar-bulletin. SILSO data: WDC-SILSO, Royal Observatory of Belgium, Brussels