Solar Bulletin

THE AMERICAN ASSOCIATION OF VARIABLE STAR OBSERVERS
SOLAR SECTION

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ISSN 0271-8480

Volume 74 Number 8 August 2018

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 Looking back on 21st August 2017.

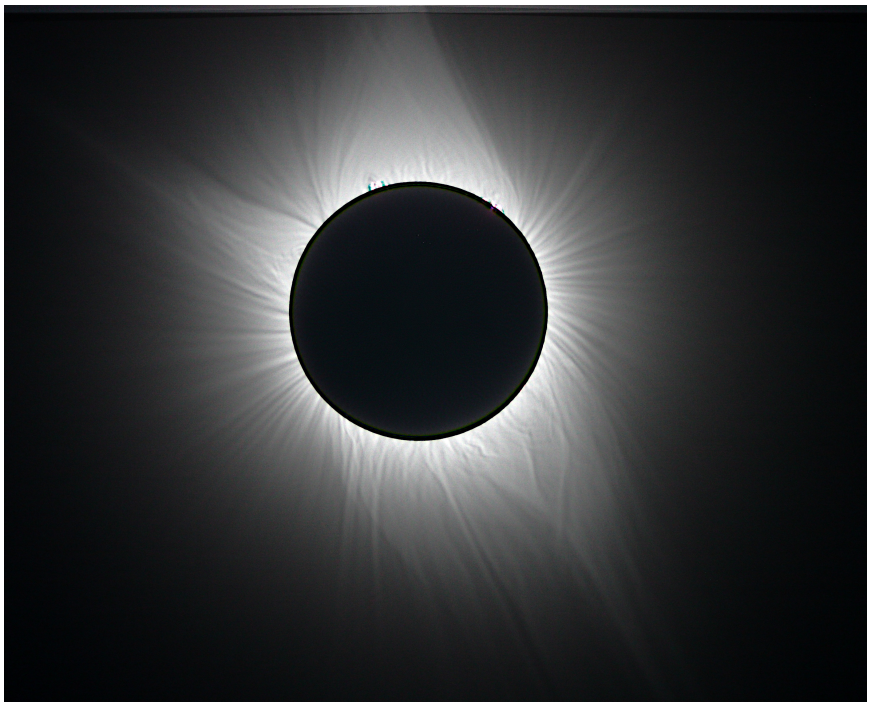

Figure 1: John O'Neill's (ONJ) image of the total solar eclipse, as seen from Guernsey State Park in Wyoming, USA where totality lasted 2 min 18 sec. A 70 mm refractor (TeleVue Pronto) was used with a DSLR camera. Five images (ranging from 1/1000 to 1/10 of a second) were combined to produced a single image in order to bring out more coronal detail. The shape of the corona was characteristic of solar minimum.

2 Sudden Ionospheric Disturbance (SID) Report

2.1 SID Records

August 2018 (Figure 2): August 23 there was an A6.8 class flare and that did show up with peak around 2038 UT; this is the first time an A class flare has been recorded here in Fort Collins, CO, and it was inverted! (This was probably because of orientation of the sun and the loop pointing east-west) August 2018 .

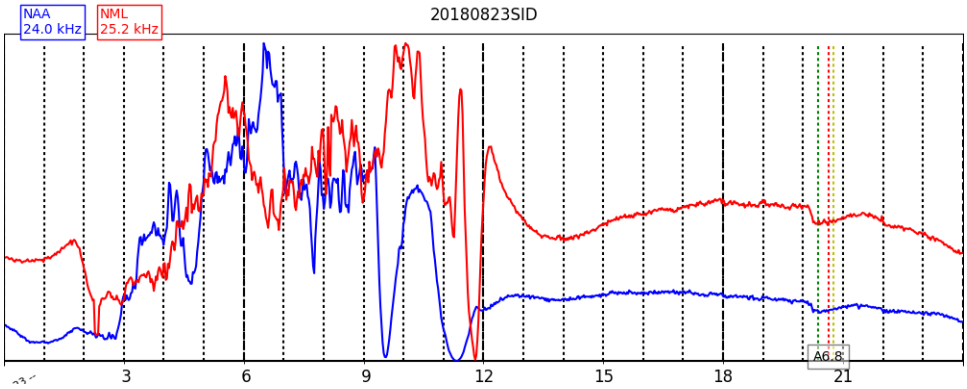

Figure 2: VLF recording at Fort Collins, Colorado.

2.2 SID Observers

This is an interesting observer from long ago: "Overlooked No More: Ruby Payne-Scott, Who Explored Space With Radio Waves" Payne-Scott helped establish the field of radio astronomy by using radio waves to detect solar bursts, but she was forced to resign after she got married. (`https://www.nytimes.com/2018/08/29/obituaries/ruby-payne-scott-overlooked.html`)

In August 2018 we had 15 AAVSO SID observers who submitted VLF data as listed in Table 1. Observers monitor from one to three stations to provide SID data.

Table 1: 201808 VLF Observers

Observer	Code	Stations
A McWilliams	A94	NML
J Wallace	A97	NAA
L Loudet	A118	DHO
J Godet	A119	GBZ ICV
B Terrill	A120	NWC
F Adamson	A122	NWC
S Oatney	A125	NML NLK NAA
J Karlovsky	A131	NSY ICV
R Green	A134	NWC
S Aguirre	A138	NPM
G Silvis	A141	NLK
I Ryumshin	A142	GQD DHO
R Rogge	A143	GQD
K Menzies	A146	NAA
R Russel	A147	NPM

Figure 3 depicts the importance rating of the solar events. The durations 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.

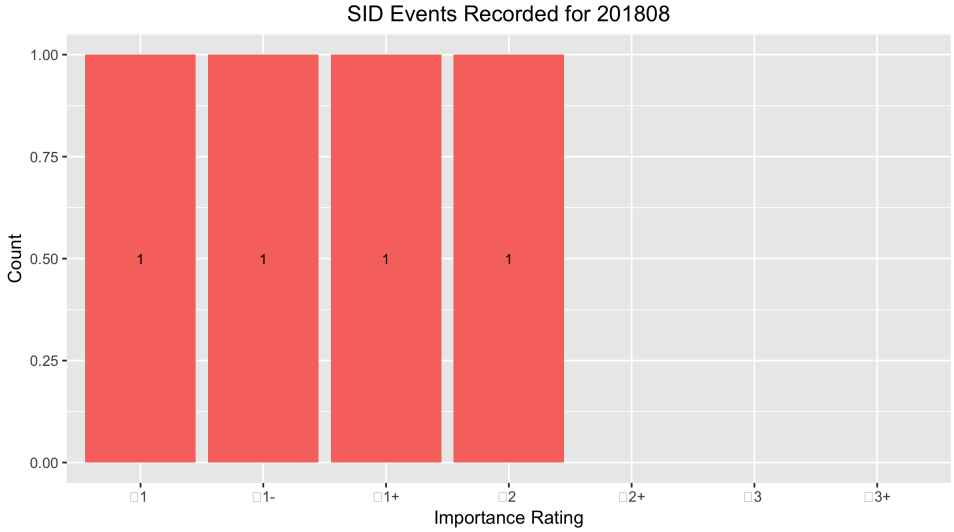

Figure 3: Solar Events Y-axis, Importance Rating X-axis.

2.3 Solar Flare Summary from GOES-15 Data

In August 2018, There were 19 solar flares measured by GOES-15 for August 2018: 12 B class, 7 A class. About the same flaring this month compared to last with 29 days of no reports from the GOES satellite. (see Figure 4).

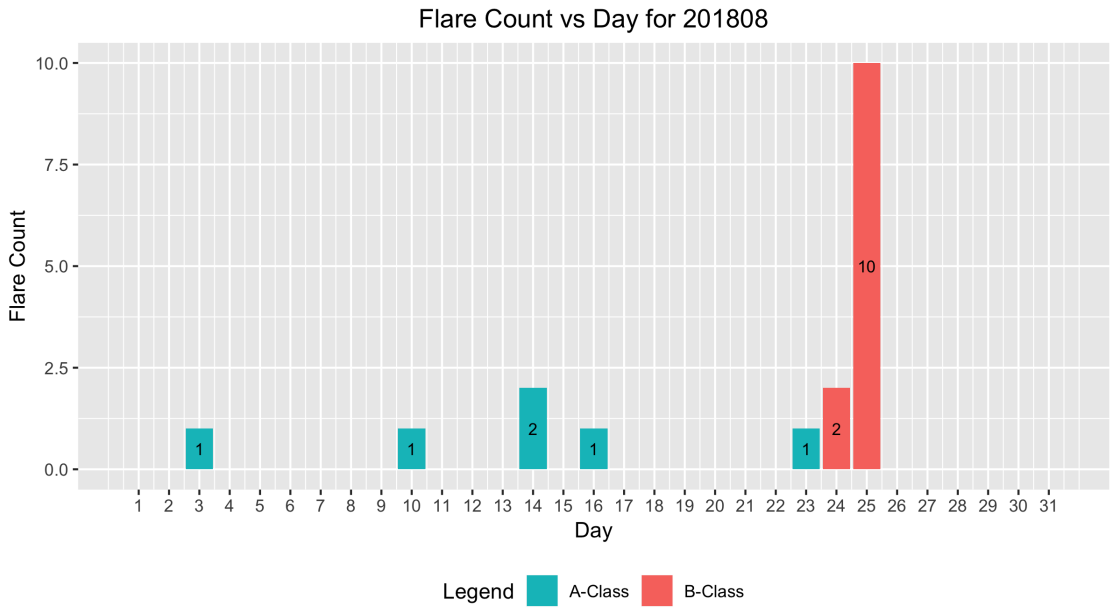

Figure 4: GOES - 15 XRA flares

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 August 2018. 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.

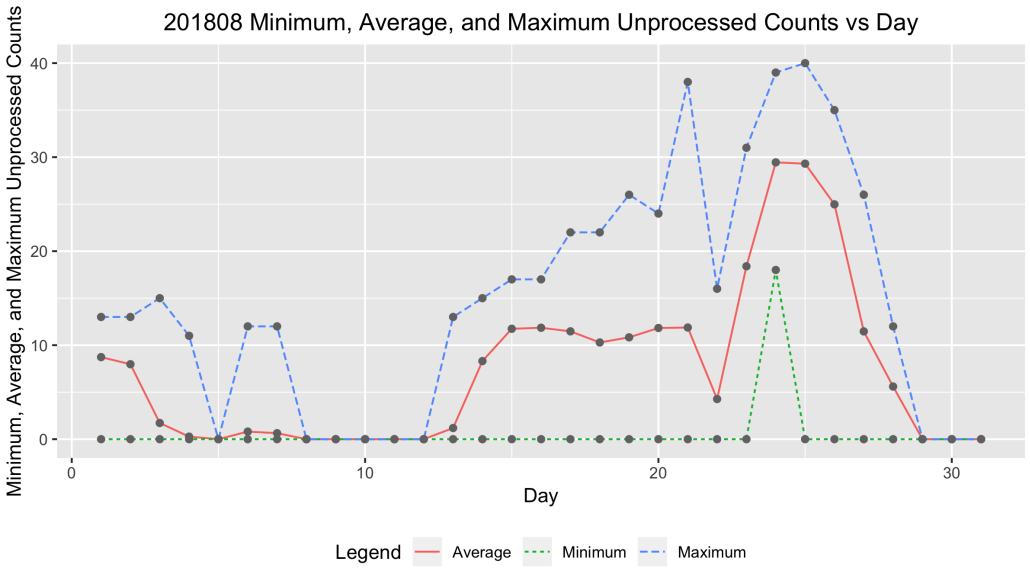

Figure 5: Raw Wolf number average, minimum and maximum by day of the month for all observers.

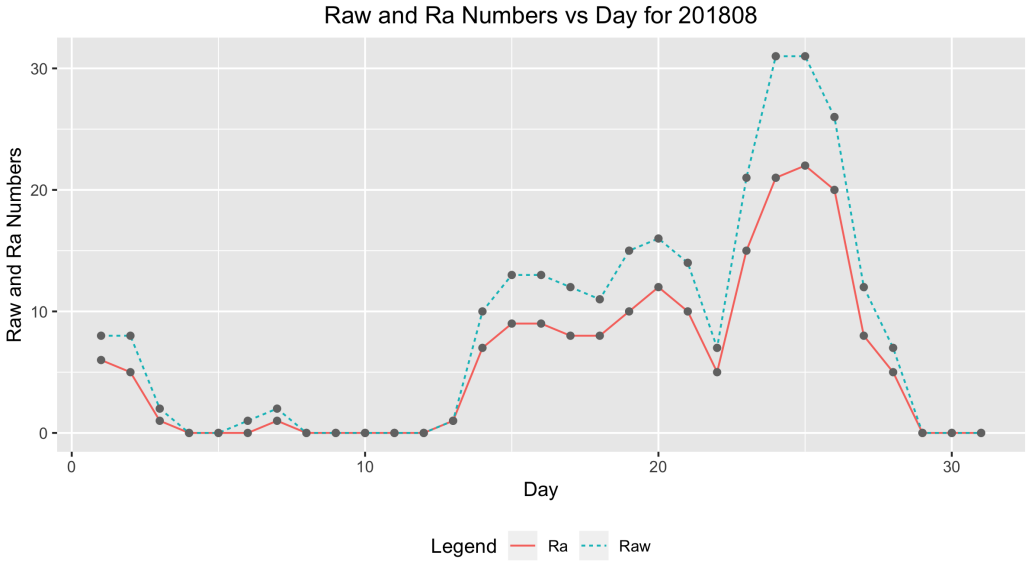

Figure 6: Raw Wolf average and R_a numbers by day of the month for all observers.

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.

Table 2: 201808 American Relative Sunspot Numbers (R_a)

Day	NumObs	Raw	R_a
1	37	8	6
2	39	8	5
3	36	2	1
4	40	0	0
5	43	0	0
6	42	1	0
7	36	2	1
8	41	0	0
9	39	0	0
10	45	0	0
11	39	0	0
12	35	0	0
13	32	1	1
14	39	10	7
15	35	13	9
16	34	13	9
17	34	12	8
18	38	11	8
19	42	15	10
20	35	16	12
21	41	14	10
22	37	7	5
23	46	21	15
24	36	31	21
25	36	31	22
26	48	26	20
27	43	12	8
28	40	7	5
29	41	0	0
30	38	0	0
31	39	0	0
Averges	38.9	8.4	5.9

3.3 Sunspot Observers

Table 3 lists the observer code (obs), the number of observations (NumObs) submitted for August 2018, and the observer's name (Name). 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 1206.

Table 3: 201808 Number of observations by observer

Obs	NumObs	Name
AAP	2	A. Patrick Abbott
AAX	23	Alexandre Amorim
AJV	19	J. Alonso
ARAG	31	Gema Araujo
ASA	27	Salvador Aguirre
ATE	18	Teofilo Arranz Heras
BARH	11	Howard Barnes
BERJ	31	Jose Alberto Berdejo
BLAJ	8	John A. Blackwell
BMF	26	Michael Boschat
BRAD	27	David Branchett
BRAF	24	Raffaello Braga
BROB	31	Robert Brown
BSAB	18	Santanu Basu
CHAG	31	German Morales Chavez
CIOA	21	Ioannis Chouinavas
CKB	30	Brian Cudnik
CNT	18	Dean Chantiles
DEMF	12	Frank Dempsey
DJOB	20	Jorge del Rosario
DMIB	27	Michel Deconinck
DROB	8	Bob Dudley
DUBF	27	Franky Dubois
EHOA	21	Howard Eskildsen
ERB	28	Bob Eramia
FERJ	25	Javier Ruiz Fernandez
FLET	26	Tom Fleming
FLF	13	Fredirico Luiz Funari
FTAA	12	Tadeusz Figiel
FUJK	23	K. Fujimori
HAYK	18	Kim Hay
HIVB	1	Ivan Hajdinjak
HMQ	3	Mark Harris
HOWR	28	Rodney Howe
JDAC	17	David Jackson
JENS	2	Simon Jenner
JGE	8	Gerardo Jimenez Lopez
JPG	1	Penko Jordanov

Continued on next page

Table 3: 201808 Number of observations by observer

Obs	NumObs	Name
KAND	31	Kandilli Observatory
KAPJ	9	John Kaplan
KROL	27	Larry Krozel
LEVM	25	Monty Leventhal
LKR	3	Kristine Larsen
LRRA	15	Robert Little
MARE	13	Enrico Mariani
MCE	27	Etsuiku Mochizuki
MILJ	22	Jay Miller
MJHA	29	John McCammon
MUDG	19	George Mudry
MWU	14	Walter Maluf
ONJ	8	John O'Neill
RLM	9	Mat Raymonde
SDOH	31	Solar Dynamics Obs - HMI
SMNA	7	Michael Stephanou
SNE	5	Neil Simmons
STAB	30	Brian Gordon-States
SUZM	26	Miyoshi Suzuki
TESD	31	David Teske
TST	18	Steven Toothman
URBP	27	Piotr Urbanski
VARG	28	A. Gonzalo Vargas
WCHD	8	Charles White
WGI	1	Guido Wollenhaupt
WILW	27	William M. Wilson
Totals	1206	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

Reporting Addresses

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

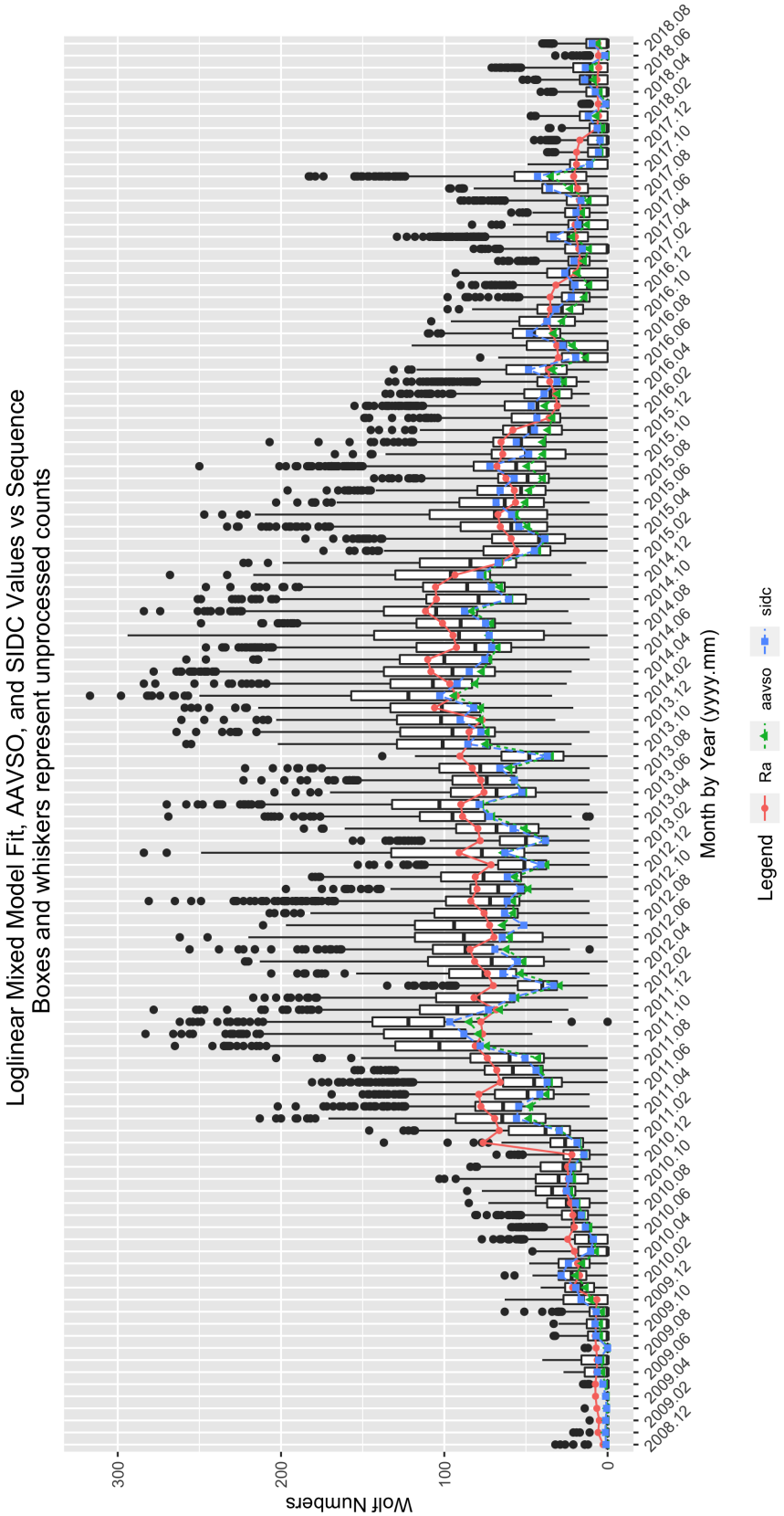

Figure 7: GLMM fitted data for R_a. AAVSO data: https://www.aavso.org/category/tags/solar-bulletin. SILSO data: WDC-SILSO, Royal Observatory of Belgium, Brussels