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. 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 Imaging the Sun

Figure 1 Hand held shot through Coronado DS SM 90 - BF 30 - C102F. The double stack optics is prone to Newton's rings when imaging, they are not there visually.

(http://scienceworld.wolfram.com/physics/NewtonsRings.html) A little solar flare around the sunspot group AR2665. Dan Laszlo, NCAS Ft Collins, Colorado.

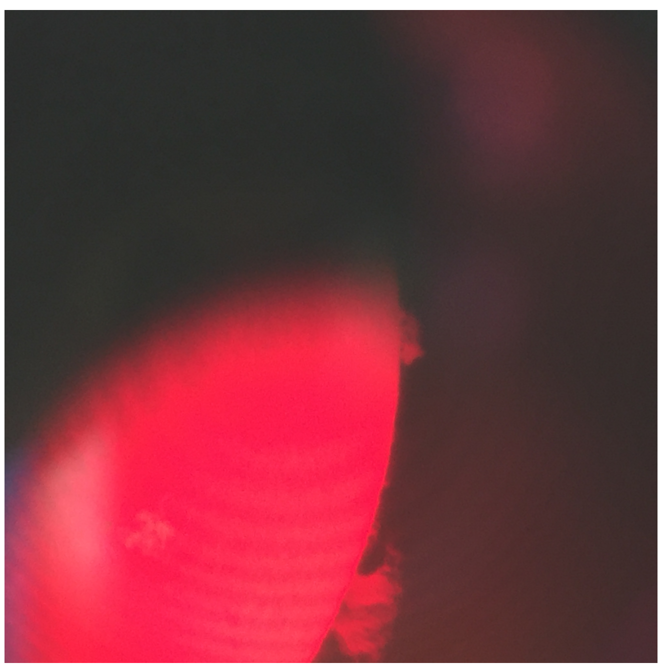

Figure 1: H Alpha image of a prominence on the limb of the sun.

Although imaging the sun with the camera can tell us many interesting things, H - alpha images are not suitable for counting sunspots. White light (or equivalent) filters are needed to count sunspots, as described in the AAVSO solar observing guide; (https://www.aavso.org/solar-observing-guide).

2 Sudden Ionospheric Disturbance (SID) Report

Sudden ionospheric disturbances (SID) occur in Earth's atmosphere by solar flares, causing large increases in the ionization in the ionosphere over the daytime regions of the Earth.

2.1 SID Records

July, 2017 (Figure 2) Rodney Howe captures the large M1.0 flare this month, on the 3rd of July, recording data from NLK (Jim Creek at 24.8 kHz), and NPM (Hawaii at 21.4 kHz).

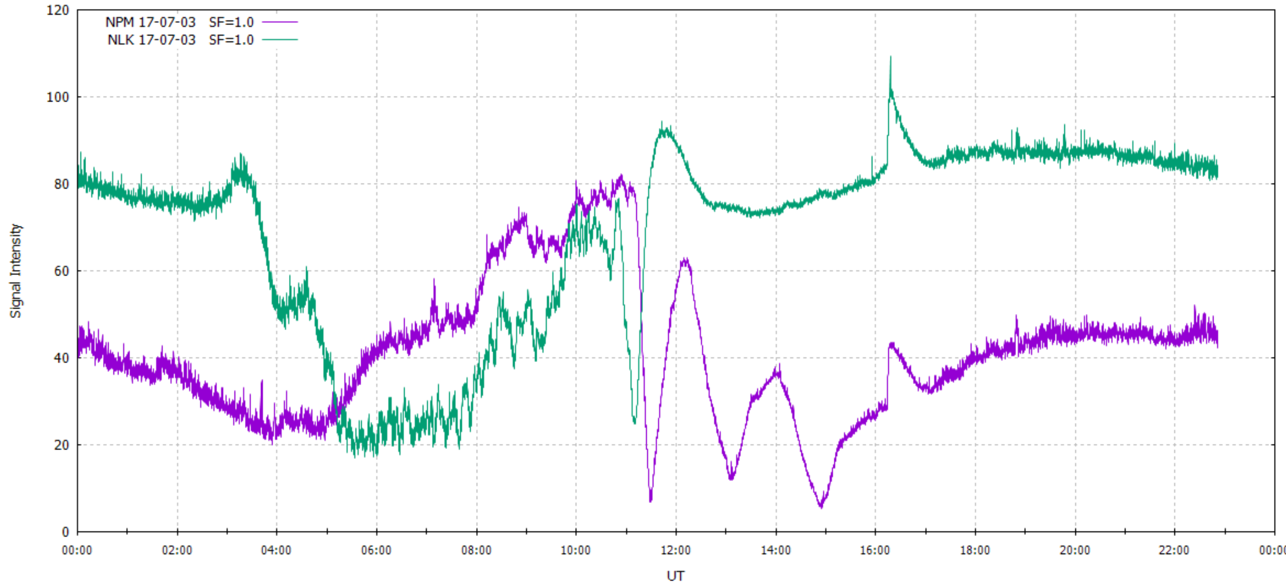

Figure 2: VLF recording of a M1.0 flare on July 3rd, 2017

2.2 SID Observers

In July, 2017 we have 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: 201707 VLF Observers

Observer	Code	Stations
A McWilliams	A94	NML
R Battaiola	A96	HWU
J Wallace	A97	NAA
L Loudet	A118	DHO
J Godet	A119	GBZ GQD ICV
F Adamson	A122	NWC
S Oatney	A125	NML
J Karlovsky	A131	DHO NSY
R Green	A134	NPM
S Aguirre	A138	NPM
G Silvis	A141	NAA NLK NPM
I Ryumshin	A142	DHO GBZ
R Rogge	A143	GQD
D Russel	A147	NML
L Ferreira	A149	NWC

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.

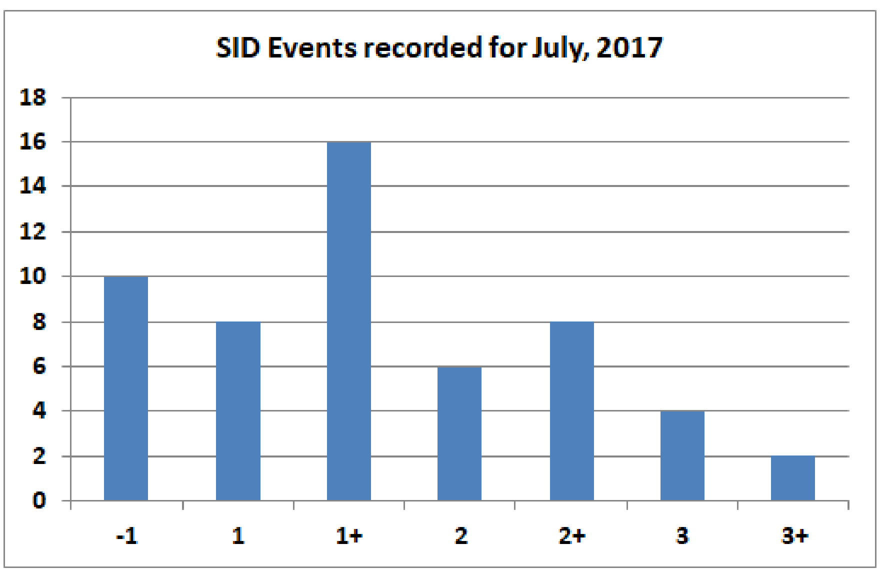

Figure 3: Solar Events Y-axis, Importance Rating X-axis.

2.3 Solar Flare Summary from GOES-15 Data

In July, 2017, there were 133 solar flares measured by GOES-15 (see Figure 4). Three M class, 33 C class and 97 B class flares. Almost twice the flaring this month compared to last, however there were 12 days of no reports from the GOES-15 satellite.

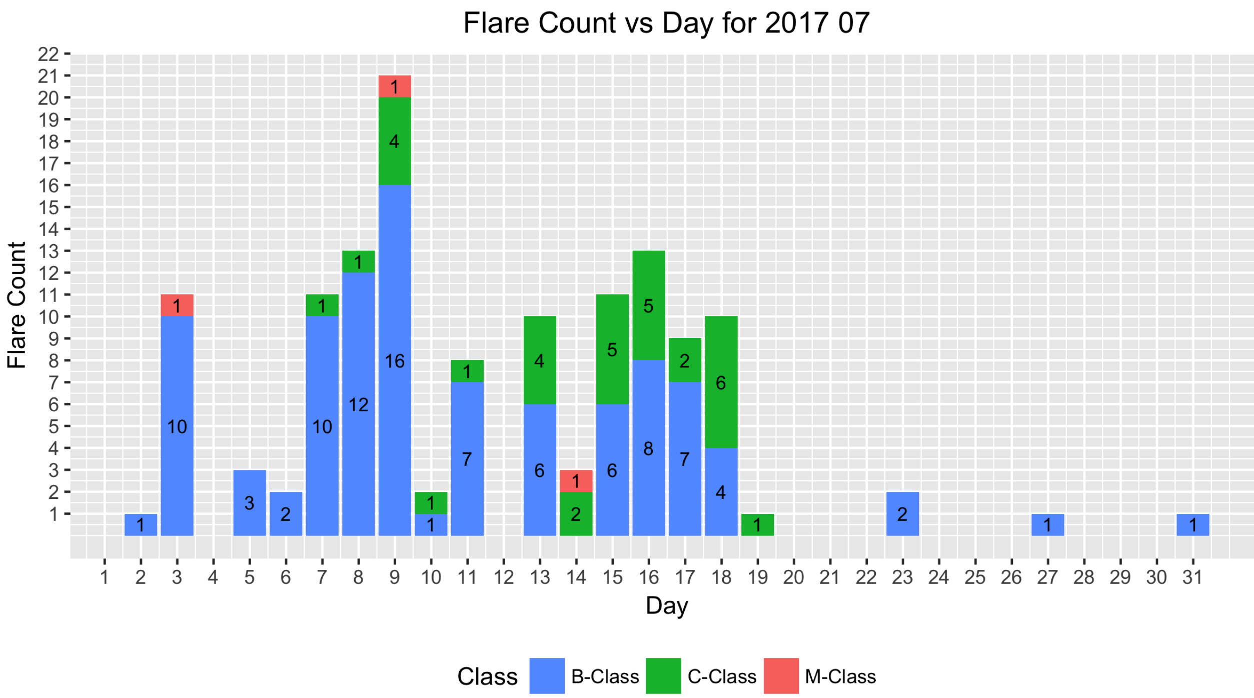

Figure 4: GOES - 15 XRA flares

3 Relative Sunspot Numbers (Ra)

Reporting monthly sunspot numbers consists of submitting 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 July, 2017. 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 6.

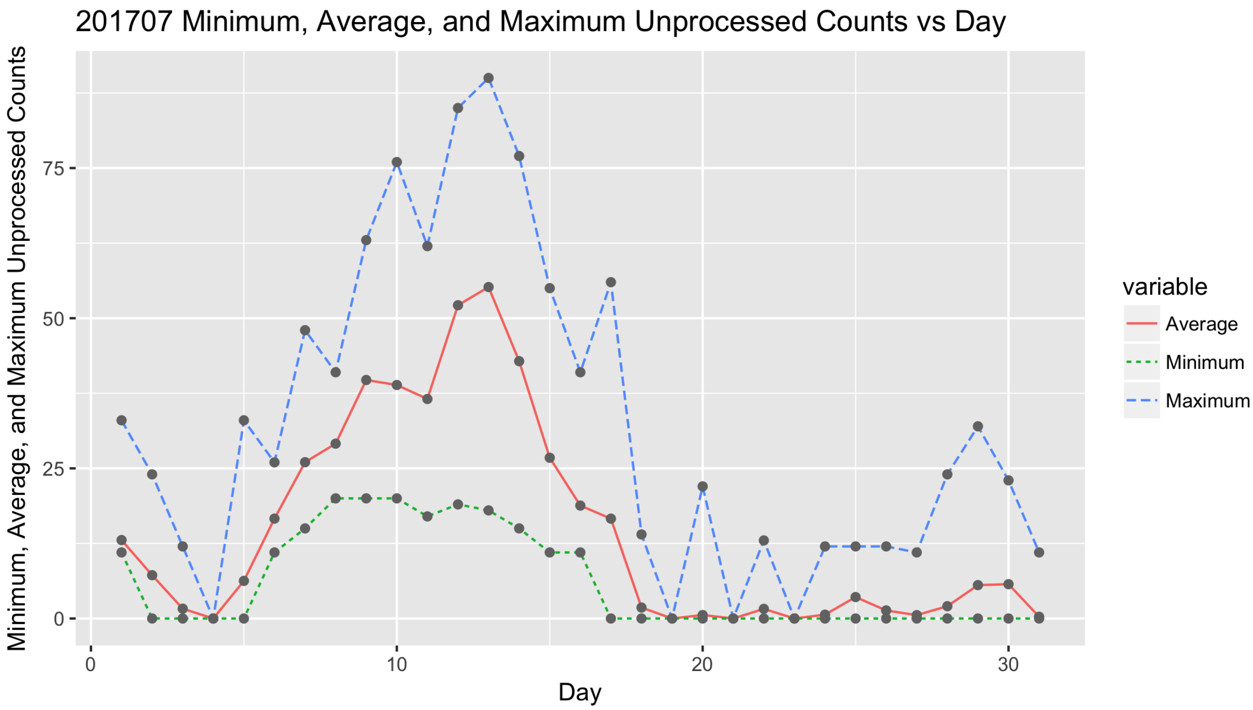

Figure 5: Raw average, minimum and maximum counts by day of the month by observer.

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. See Table 2.

Table 2: 201707 American Relative Sunspot Numbers (Ra)

Day	NumObs	Raw	Ra
1	34	12	9
2	42	8	5
3	41	2	1
4	43	0	0
5	41	7	6
6	38	17	14
7	40	27	21
8	45	29	24
9	45	41	33
10	41	41	31
11	38	38	30
12	37	56	43
13	37	60	44
14	38	43	34
15	43	28	22

Continued

Table 2: 201707 American Relative Sunspot Numbers (Ra)

Day	NumObs	Raw	Ra
16	40	19	15
17	40	18	13
18	40	1	1
19	38	0	0
20	38	0	0
21	41	0	0
22	43	2	1
23	36	0	0
24	36	0	0
25	35	4	3
26	35	1	0
27	39	0	0
28	40	1	1
29	34	5	4
30	35	5	3
31	38	0	0
Averges	39.1	15	11.5

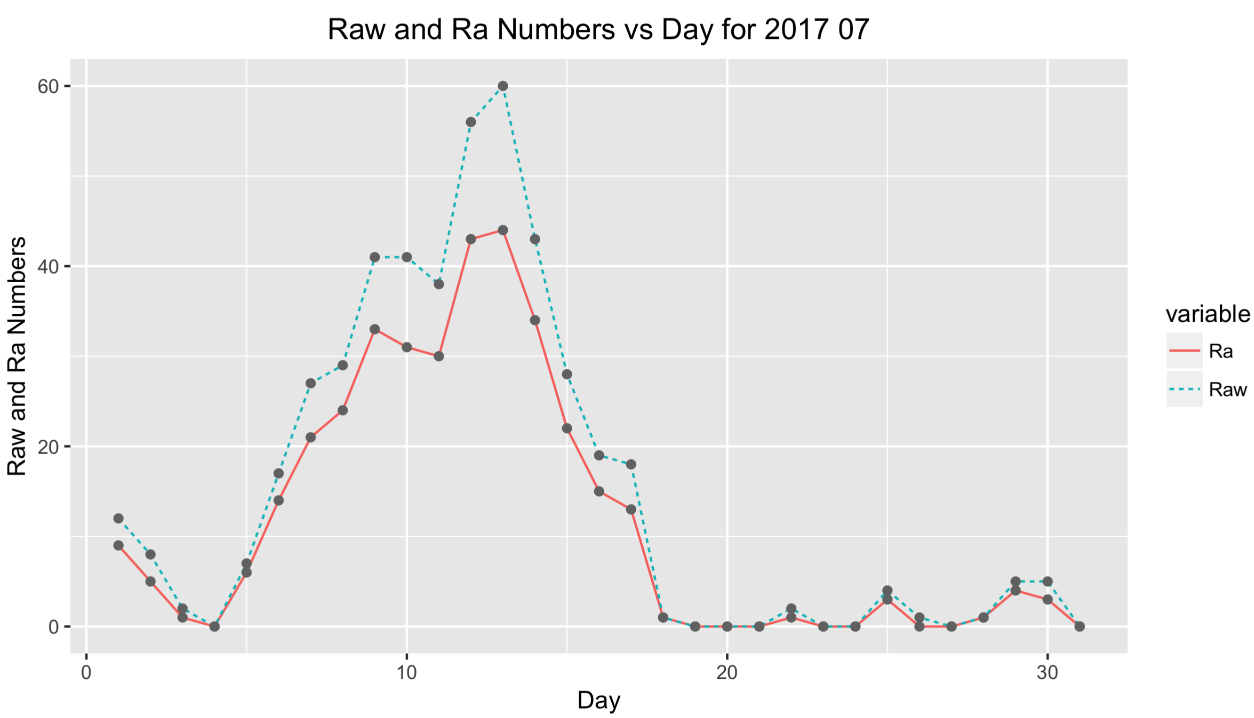

Figure 6: Raw Wolf and Ra numbers by day of the month by observer.

3.3 Sunspot Observers

Table 3 lists the observer code (obs), the number of observations submitted for July, 2017, and the observer's name. The final rows of the table give total number of observers who submitted sunspot counts and the total number of observations submitted. The total number of observers is 63 and the total number of observations is 1211.

Table 3: 201707 Number of observations by observer

Obs	NumObs	Name
AAP	7	A. Patrick Abbott
AAX	27	Alexandre Amorim
AJV	26	J. Alonso
ARAG	31	Gema Araujo
ASA	25	Salvador Aguirre
BARH	10	Howard Barnes
BATR	10	Roberto Battaiola
BERJ	27	Jose Alberto Berdejo
BRAB	30	Brenda Branchett
BRAF	24	Raffaello Braga
BROB	31	Robert Brown
BSAB	15	Santanu Basu
CHAG	31	German Morales Chavez
CIOA	17	Ioannis Chouinavas
CKB	30	Brian Cudnik
CNT	8	Dean Chantiles
CVJ	29	Jose Carvajal
DEMF	7	Frank Dempsey
DJOB	15	Jorge del Rosario
DUBF	30	Franky Dubois
FERJ	23	Javier Ruiz Fernandez
FLET	28	Tom Fleming
FUJK	24	K. Fujimori
HAYK	21	Kim Hay
HIVB	7	Ivan Hajdinjak
HMQ	5	Mark Harris
HOWR	29	Rodney Howe
HRUT	23	Timothy Hrutkay
JDAC	15	David Jackson
JENS	2	Simon Jenner
JGE	6	Gerardo Jimenez Lopez
KAND	26	Kandilli Observatory
KAPJ	25	John Kaplan
KNJS	31	James & Shirley Knight
KROL	26	Larry Krozel
LEVM	26	Monty Leventhal
LKR	4	Kristine Larsen
LRRA	24	Robert Little

Continued on next page

Table 3: 201707 Number of observations by observer

Obs	NumObs	Name
MARE	15	Enrico Mariani
MCE	23	Etsuiku Mochizuki
MILJ	12	Jay Miller
MJAF	31	Juan Antonio Moreno Quesada
MJHA	31	John McCammon
MMAE	5	Aaron McNeely
MMAV	29	Marcelino
MUDG	15	George Mudry
MWU	18	Walter Maluf
OATS	6	Susan Oatney
ONJ	12	John O'Neill
RLM	10	Mat Raymonde
SDOH	31	Solar Dynamics Obs - HMI
SIMC	10	Clyde Simpson
SMNA	5	Michael Stephanou
SNE	7	Neil Simmons
SONA	20	Andries Son
STAB	31	Brian Gordon-States
SUZM	25	Miyoshi Suzuki
TESD	31	David Teske
TPJB	4	Patrick Thibault
VARG	30	A. Gonzalo Vargas
VIDD	6	Dan Vidican
WAU	1	Artur Wargin
WILW	28	William M. Wilson
Totals	1211	63

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 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. The solid cyan curve that connects the red X's are 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 are the Shapley method R_a numbers. The dashed blue curve connecting the blue O's are 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 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

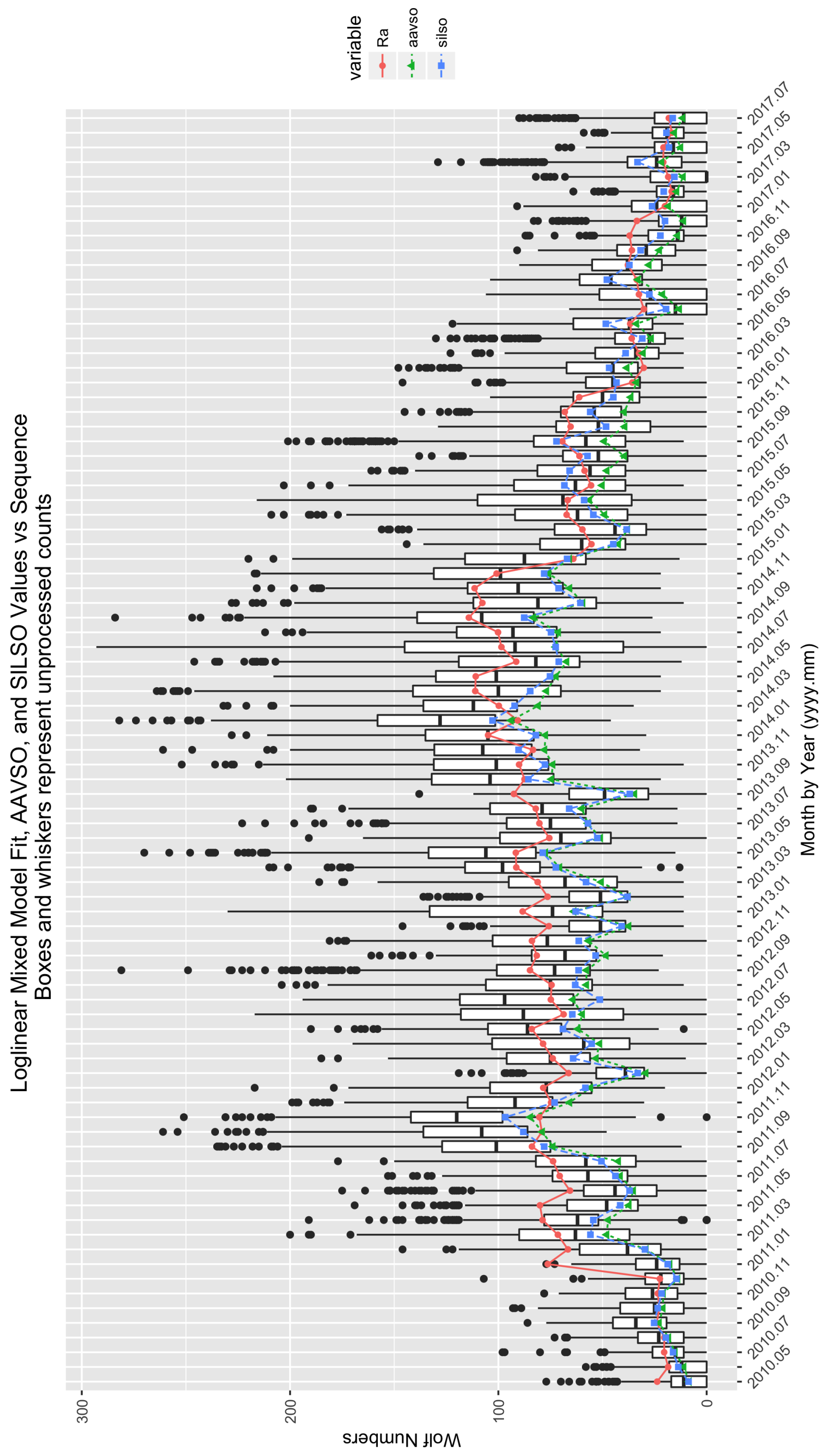

Figure 7: GLMM fitted data for R_a. AAVSO data: https://www.aavso.org/category/tags/solar-bulletin. SILSO data: WDC-SILSO, Royal Observatory of Belgium, Brussels