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

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

Volume 73 Number 8 August 2017

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 Susan Oatney took this on August 21, 2017 at the Guernsey State Park in Wyoming with a little Nikon COOLPIX 20.1 mega-pixels at a zoom of 2x.

Figure 1: Image of the August 21, 2017 total eclipse of the sun.

Although imaging the total eclipse of the sun with the camera can show the close in corona, actually being present at totality is quite something else.

. . .

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

August 2017 (Figure 2) Rodney Howe captures the solar eclipse recording data from NML (La Moure, ND at 25.2 kHz), NPM (Hawaii at 21.4 kHz) and NAA (Cutler, ME at 24 kHz). Even though the Naval transmitter at Cutler, ME was down for maintenance on Monday, August 21, 2017 there was still an eclipse signature at 1800 UT.

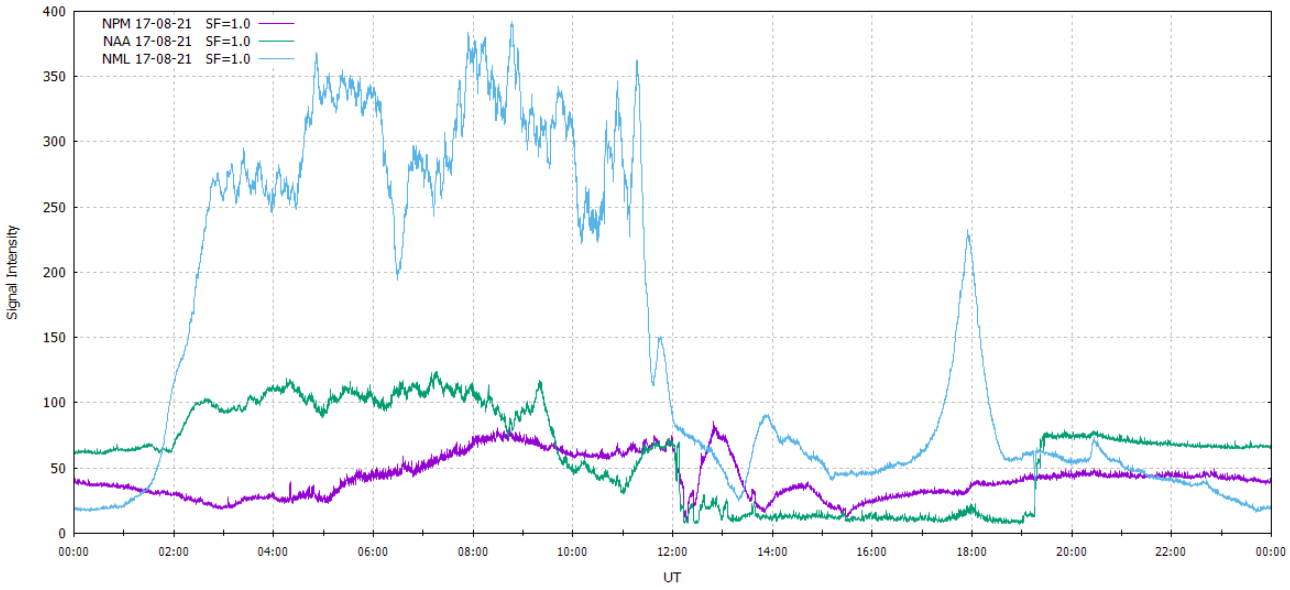

Figure 2: VLF recordings of the solar eclipse August 21, 2017

2.2 SID Observers

In August 2017 we have 16 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: 201708 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
B Terrill	A120	NWC
F Adamson	A122	NWC
S Oatney	A125	NML
J Karlovsky	A131	DHO NSY
R Green	A134	NWC
S Aguirre	A138	NPM
G Silvis	A141	NAA NPM
I Ryumshin	A142	DHO GBZ
R Rogge	A143	DHO GQD ICV
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.

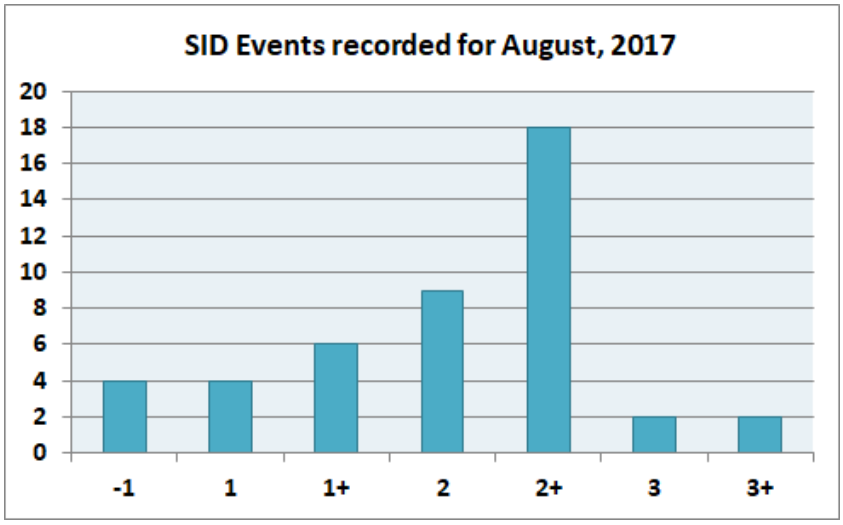

Figure 3: Solar Events Y-axis, Importance Rating X-axis.

2.3 Solar Flare Summary from GOES-15 Data

In August 2017, there were 170 solar flares measured by GOES-15 (see Figure 4). One M class, 43 C class and 126 B class flares. Almost twice the flaring this month compared to last, however there were 8 days of no reports from the GOES-15 satellite.

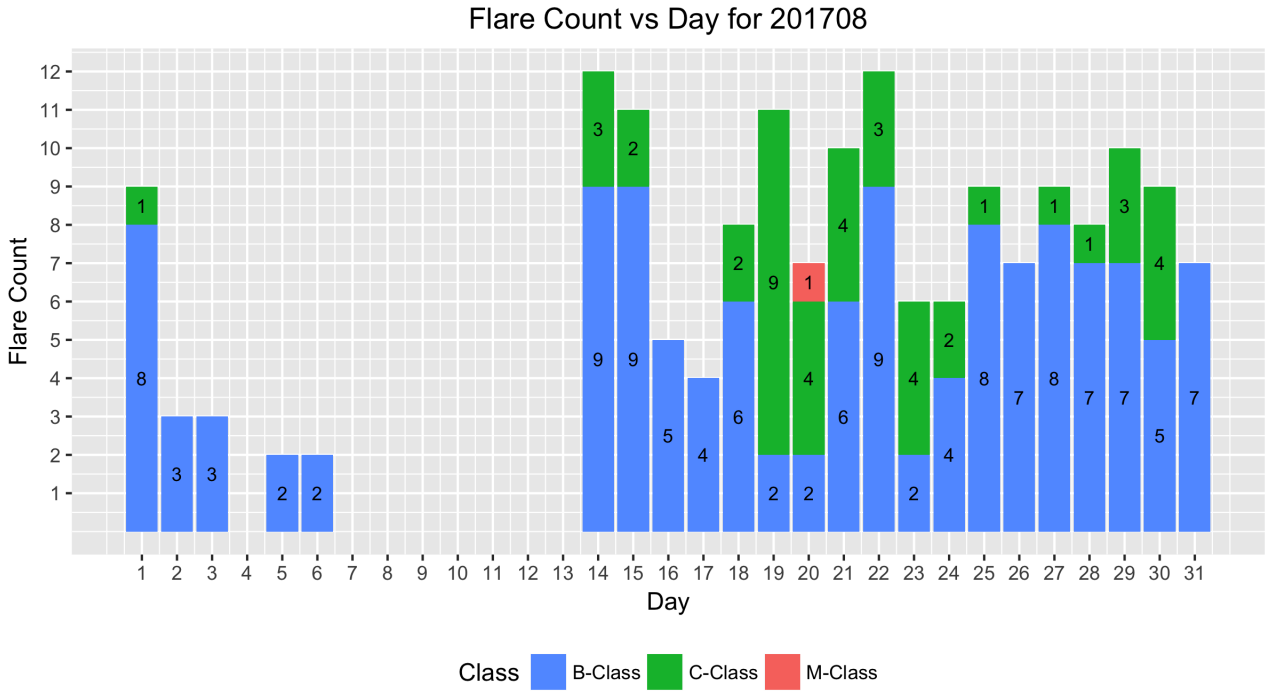

Figure 4: GOES - 15 XRA flares

3 Relative Sunspot Numbers (Ra)

Reporting monthly sunspot numbers consists of submitting 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 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.

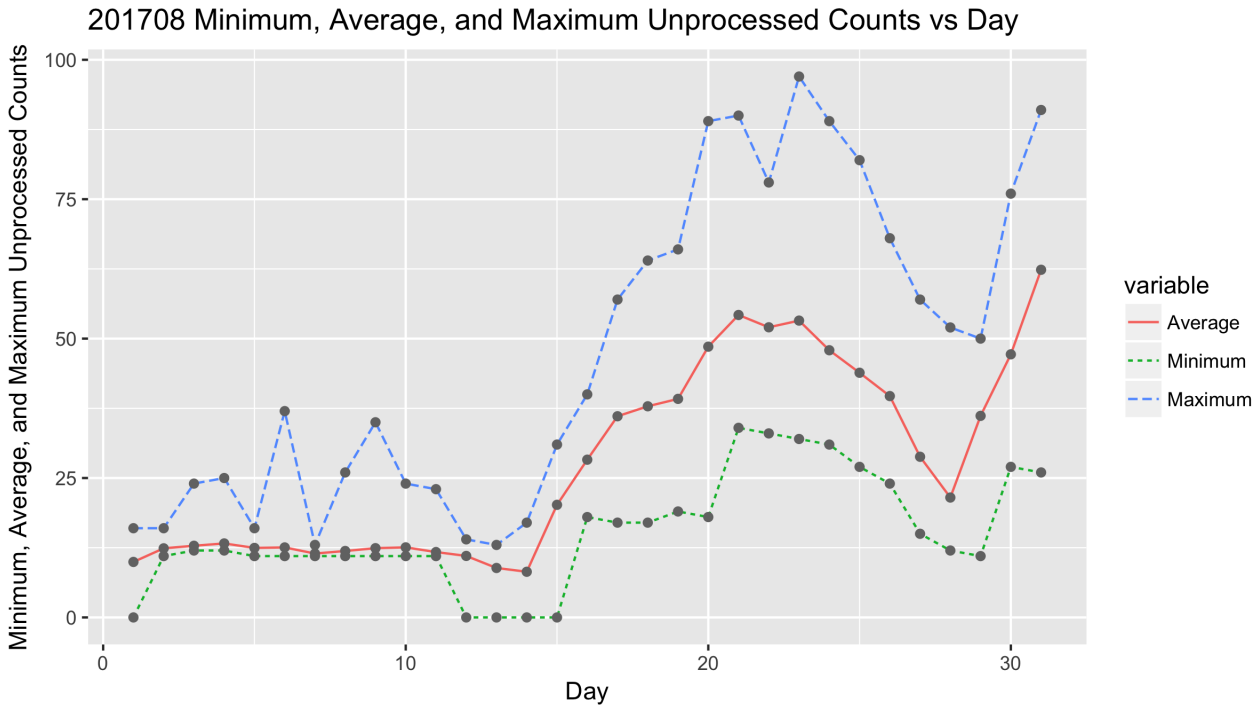

Figure 5: Raw average, minimum and maximum counts by day of the month by observer.

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: 201708 American Relative Sunspot Numbers (Ra)

Day	NumObs	Raw	(R_a)
1	42	10	9
2	38	13	10
3	34	13	11
4	37	13	11
5	43	13	11
6	36	12	10
7	35	11	9
8	36	12	10
9	38	12	11
10	37	12	9
11	40	12	10
12	35	12	9
13	38	9	7
14	37	10	8
15	36	20	17

Continued

Table 2: 201708 American Relative Sunspot Numbers (Ra)

Day	NumObs	Raw	(R_a)
16	31	30	24
17	39	37	29
18	37	38	31
19	31	42	33
20	36	50	39
21	38	55	46
22	32	53	42
23	39	53	43
24	35	48	38
25	41	47	35
26	36	40	33
27	37	30	25
28	30	21	17
29	34	37	30
30	33	49	42
31	32	63	49
Averages	36.2	28.3	22.8

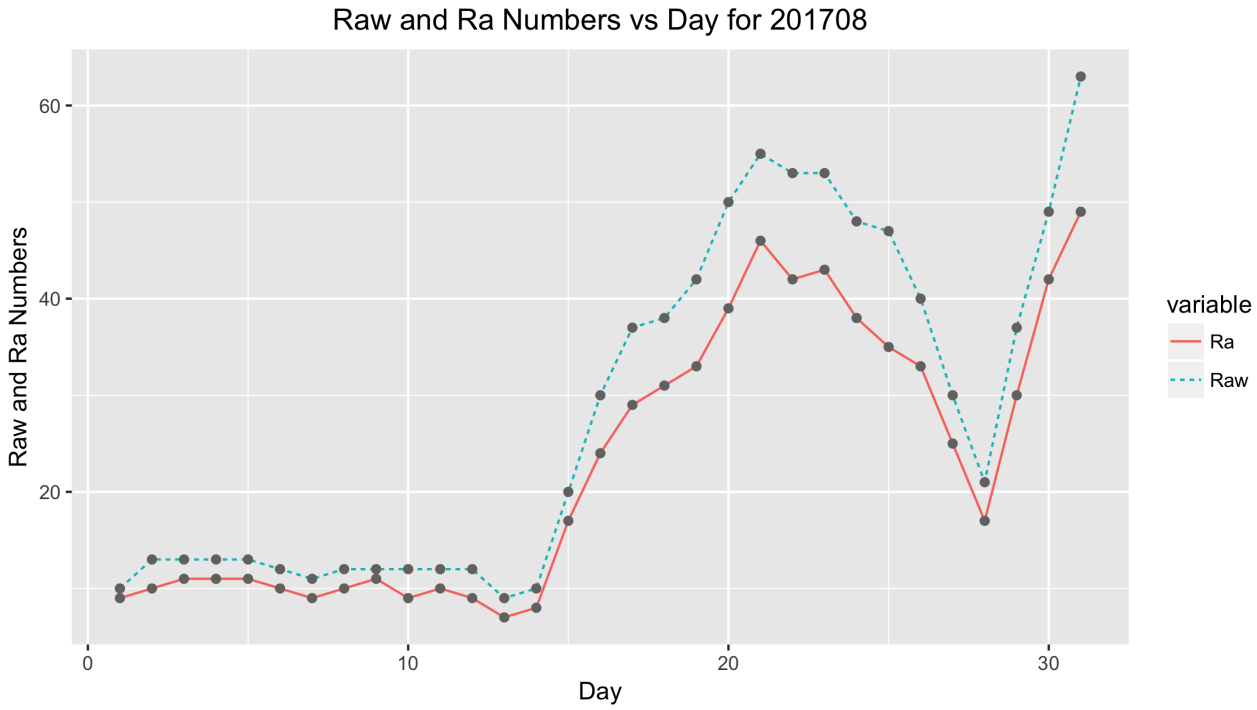

Figure 6: Raw Wolf and Ra numbers by day of the month by observer.

3.3 Sunspot Observers

Table 3 lists the observer code (obs), the number of observations submitted for August 2017, and the observer's 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 63 and the total number of observations is 1123.

Table 3: 201708 Number of observations by observer

Obs	NumObs	Name
AAP	9	A. Patrick Abbott
AAX	20	Alexandre Amorim
ARAG	31	Gema Araujo
ASA	23	Salvador Aguirre
BARH	10	Howard Barnes
BERJ	25	Jose Alberto Berdejo
BMF	24	Michael Boschat
BRAB	28	Brenda Branchett
BRAF	23	Raffaello Braga
BROB	30	Robert Brown
BSAB	12	Santanu Basu
CHAG	30	German Morales Chavez
CIOA	11	Ioannis Chouinavas
CKB	18	Brian Cudnik
CNT	10	Dean Chantiles
CVJ	25	Jose Carvajal
DJOB	27	Jorge del Rosario
DUBF	21	Franky Dubois
FERJ	20	Javier Ruiz Fernandez
FLET	26	Tom Fleming
FLF	12	Fredirico Luiz Funari
FUJK	23	K. Fujimori
HAYK	16	Kim Hay
HIVB	8	Ivan Hajdinjak
HMQ	8	Mark Harris
HOWR	23	Rodney Howe
HRUT	21	Timothy Hrutkay
JDAC	14	David Jackson
JENS	1	Simon Jenner
JGE	15	Gerardo Jimenez Lopez
JPG	2	Penko Jordanov
KAND	30	Kandilli Observatory
KAPJ	21	John Kaplan
KNJS	31	James & Shirley Knight
KROL	22	Larry Krozel
LEVM	27	Monty Leventhal
LKR	8	Kristine Larsen
LRRA	23	Robert Little

Continued on next page

Table 3: 201708 Number of observations by observer

Obs	NumObs	Name
MARE	18	Enrico Mariani
MILJ	9	Jay Miller
MJAF	25	Juan Antonio Moreno Quesada
MJHA	30	John McCammon
MMAE	3	Aaron McNeely
MMAV	27	Marcelino
MUDG	9	George Mudry
MWU	10	Walter Maluf
OATS	3	Susan Oatney
ONJ	4	John O'Neill
RLM	13	Mat Raymonde
SDOH	31	Solar Dynamics Obs - HMI
SIMC	5	Clyde Simpson
SMNA	7	Michael Stephanou
SNE	4	Neil Simmons
SONA	15	Andries Son
STAB	29	Brian Gordon-States
SUZM	27	Miyoshi Suzuki
TESD	26	David Teske
TPJB	4	Patrick Thibault
URBP	27	Piotr Urbanski
VARG	30	A. Gonzalo Vargas
VIDD	16	Dan Vidican
WILW	22	William M. Wilson
WRP	1	Russell Wheeler
Totals	1123	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 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

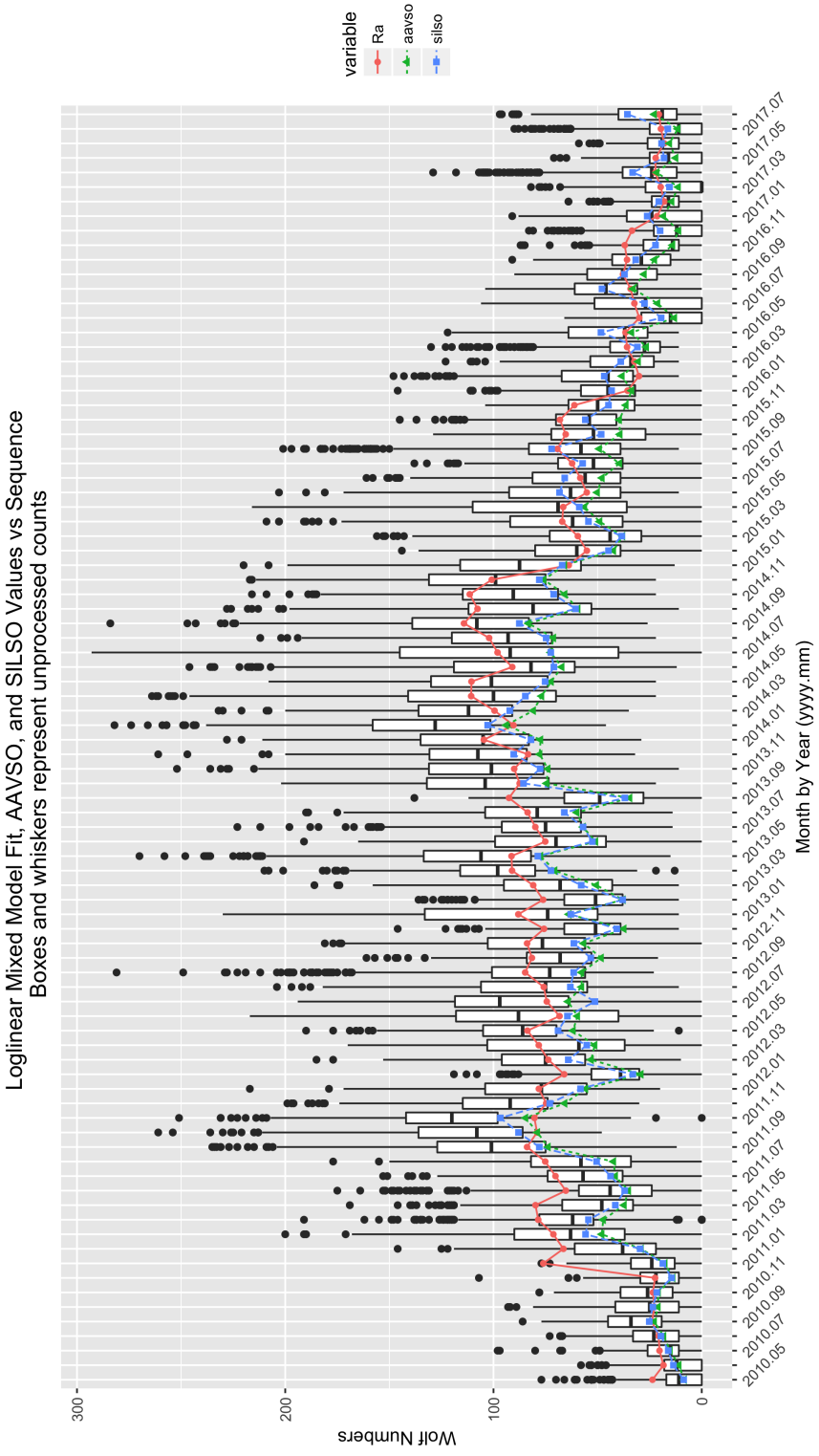

Figure 7: GLMM fitted data for R_a. AAVSO data: https://www.aavso.org/category/tags/solar-bulletin. SILSO data: WDC-SILSO, Royal Observatory of Belgium, Brussels