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.

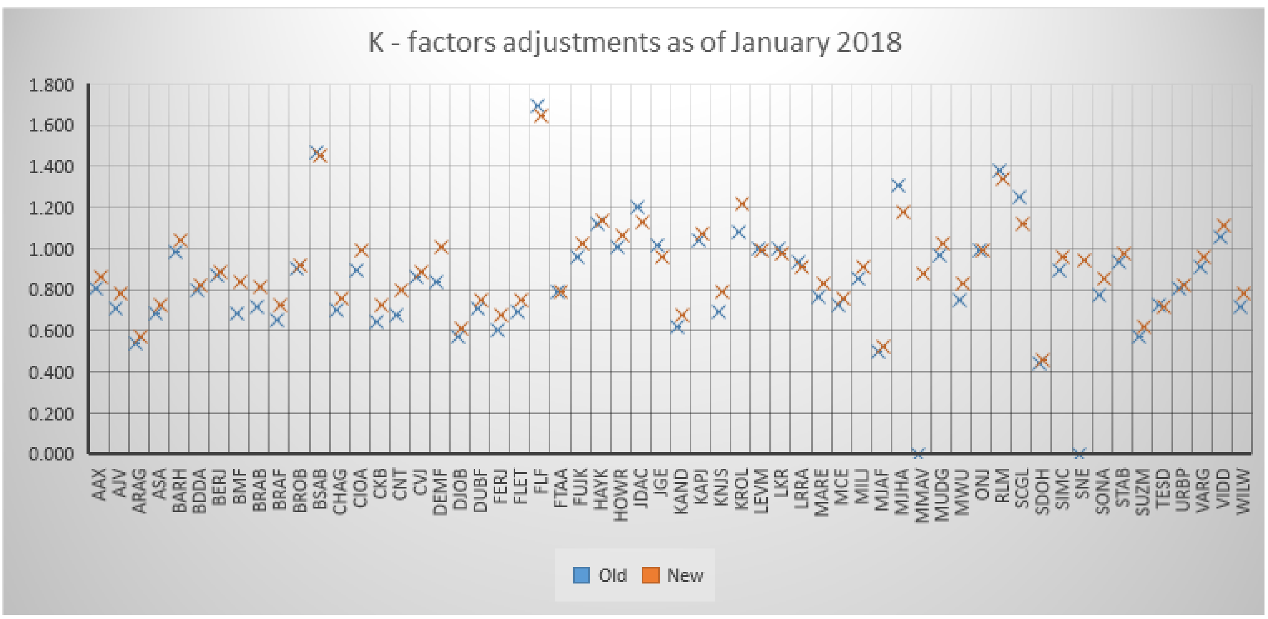

Figure 1: January every year we calculate the observer k-factors from the previous two years of observations. This will create new k factors for those who have over 100 observations, and given the changes in overall sunspot counts for all observers will change the old k - factors to new adjusted k - factors.

There were 59 observers who qualify for new k - factors this year, however, we will not use these new k factors as there are issues with many days of zero sunspot counts. This has the potential for raising the overall k - factor averages for the year. As you can see in the graph above most of the k -factors increased, the overall average for all observers increased from .8 to .92.

1 Aperture sizes for methods of direct and projection

The aperture sizes for those observers who use the direct method are generally less than 150 mm. And, some of the observers who use the projection method have apertures sizes up to 320 mm. Below we show that as the aperture sizes change in size so do the sunspot and Wolf numbers change between different observers. This just shows that different observers with different telescope methods and apertures count sunspots differently. These various counts and methods pretty much get averaged out with their k - factor calculations. 2 and 3.

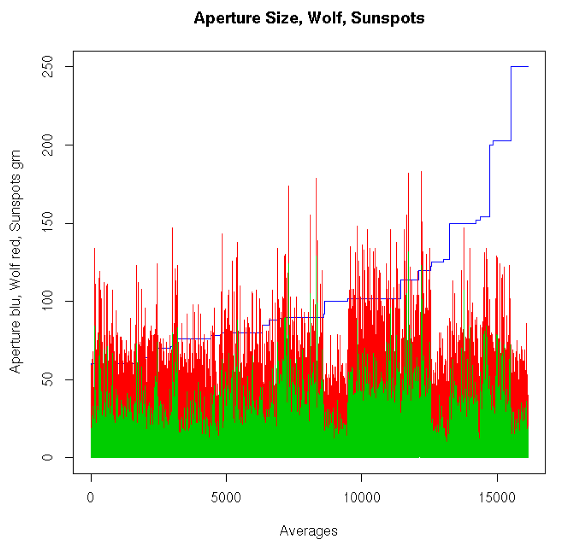

Figure 2: The aperture sizes for the direct method for 2016 - 2017 data.

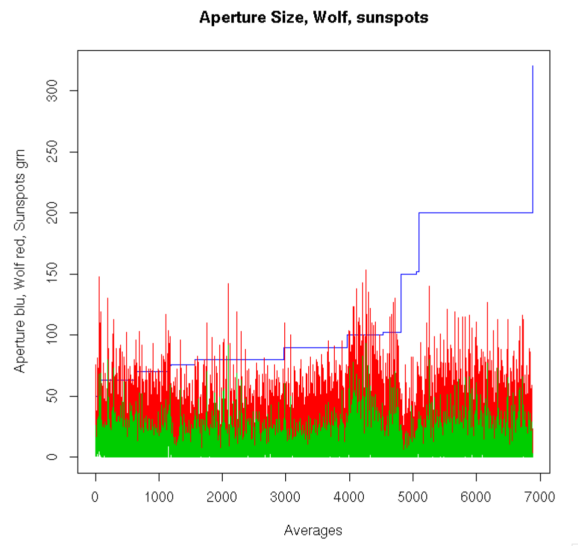

Figure 3: The aperture sizes for the projection method for 2016 - 2017 data.

Figures 2 and 3. Show the the direct and projection aperture sizes along with sunspot counts and Wolf numbers for each aperture size for years 2016 and 2017.

2 Sudden Ionospheric Disturbance (SID) Report

Here we show how a 24 bit external sound card can be used to record VLF SID data without a receiver or any electric amplification: (`https://www.asus.com/us/Sound-Cards/Xonar_U5/`) And a Pi Zero computer running Linux (Jessie) operating system.

Figure 4: The Xonar external sound card (black box) and Pi Zero computer (foreground)

2.1 SID Records

January 2018 (Figure 5) There were no SID events recorded during any day here in Fort Collins, Colorado. So, this is what the average day looked like for the month of January 2018.

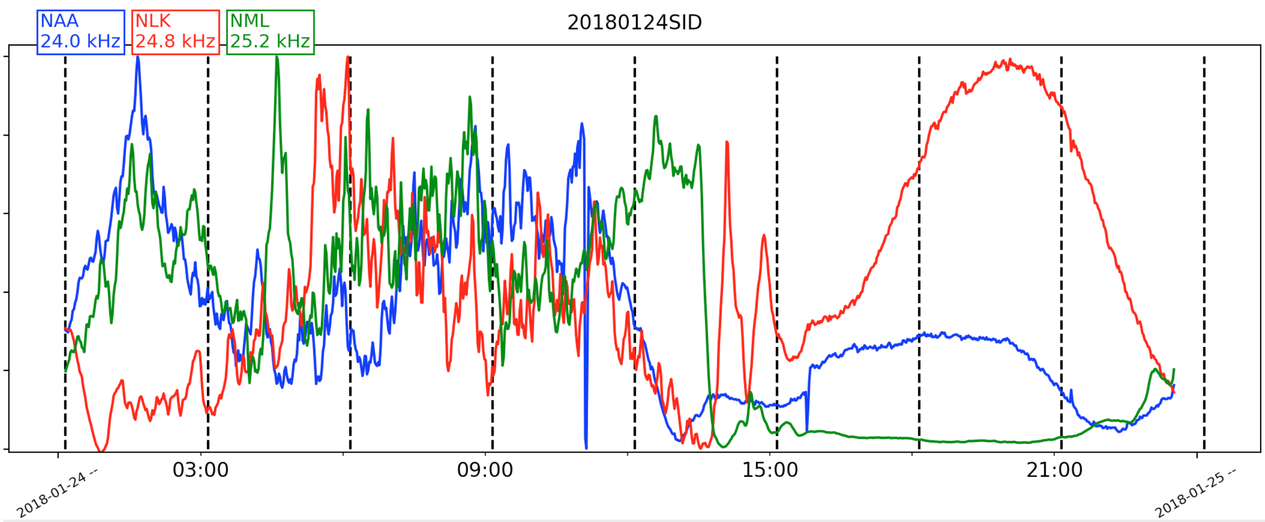

Figure 5: VLF recording using the sidmon.py software from Nathan Towne.

2.2 SID Observers

In January 2018 we have 14 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: 201712 VLF Observers

Observer	Code	Stations
A McWilliams	A94	NML
R Battaiola	A96	ICV
J Wallace	A97	NAA
L Loudet	A118	GBZ
J Godet	A119	GBZ GQD ICV
B Terrill	A120	NWC
F Adamson	A122	NWC
J Karlovsky	A131	DHO NSY
R Green	A134	NWC
S Aguirre	A138	NPM
R Rogge	A143	DHO GQD ICV
K Menzies	A146	NAA
D Russel	A147	NML
L Ferreira	A149	NWC

Figure 6 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.

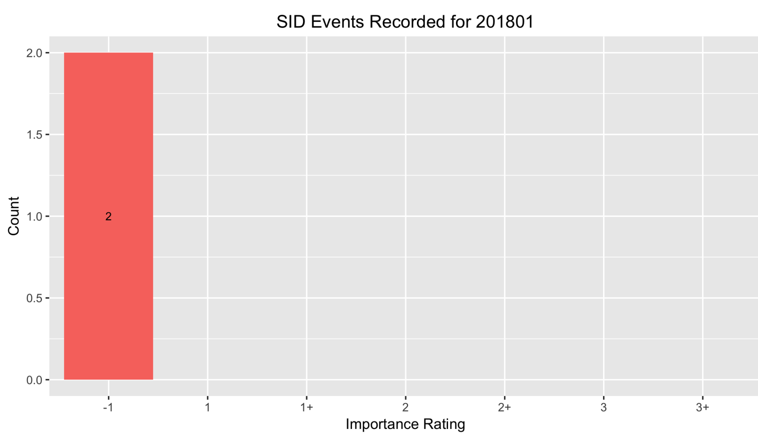

Figure 6: Solar Events Y-axis, Importance Rating X-axis.

2.3 Solar Flare Summary from GOES-15 Data

In January 2018, There were 7 solar flares measured by GOES-15. Seven B class flares. A lot less flaring this month compared to last month. There were 24 days this month with no GOES-15 reports of flares. (see Figure 7).

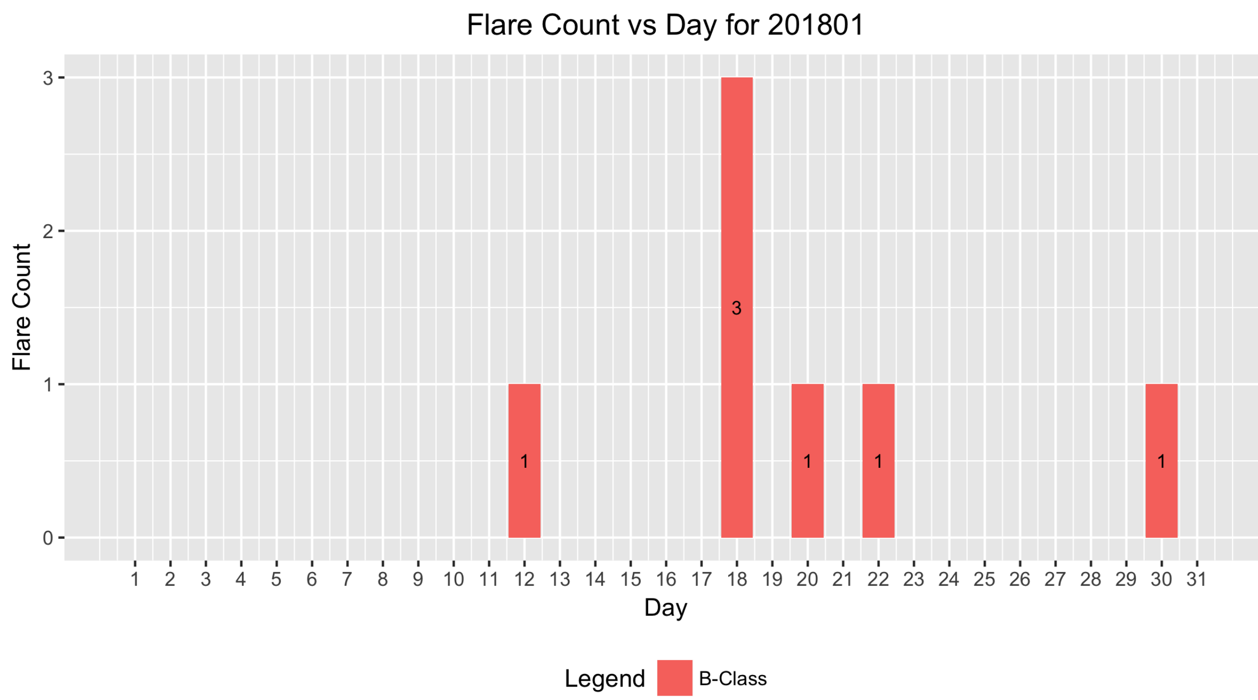

Figure 7: GOES - 15 XRA flares

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 January 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 9.

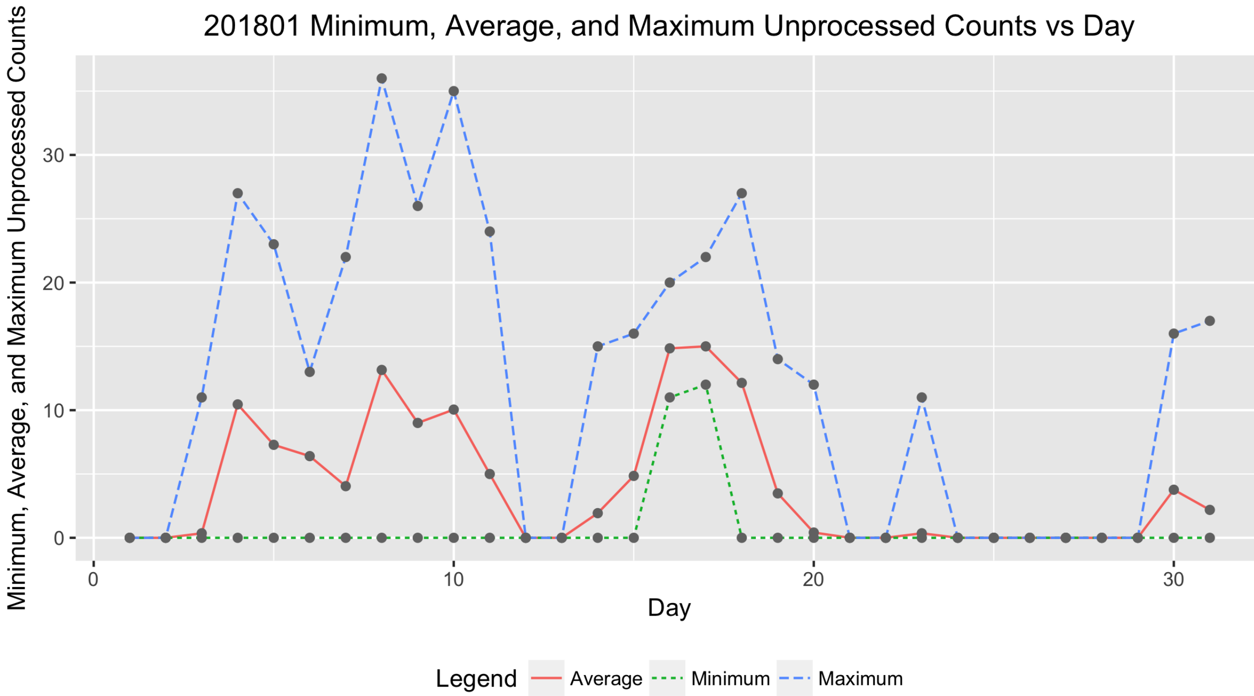

Figure 8: Raw average, minimum and maximum counts by day of the month by observer.

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: 201801 American Relative Sunspot Numbers (Ra)

Day	NumObs	Raw	Ra
1	33	0	0
2	30	0	0
3	31	0	0
4	33	12	8
5	28	9	6
6	35	10	7
7	22	5	3
8	13	13	9
9	17	8	5
10	21	17	10
11	19	5	3
12	23	0	0
13	30	0	0
14	29	0	0
15	20	6	4

Continued

Table 2: 201801 American Relative Sunspot Numbers (Ra)

Day	NumObs	Raw	Ra
16	26	15	11
17	23	13	11
18	29	13	10
19	25	7	4
20	29	2	1
21	32	0	0
22	22	0	0
23	31	0	0
24	27	0	0
25	26	0	0
26	35	0	0
27	27	0	0
28	29	0	0
29	23	0	0
30	30	4	3
31	32	4	2
Averges	26.8	4.6	3.1

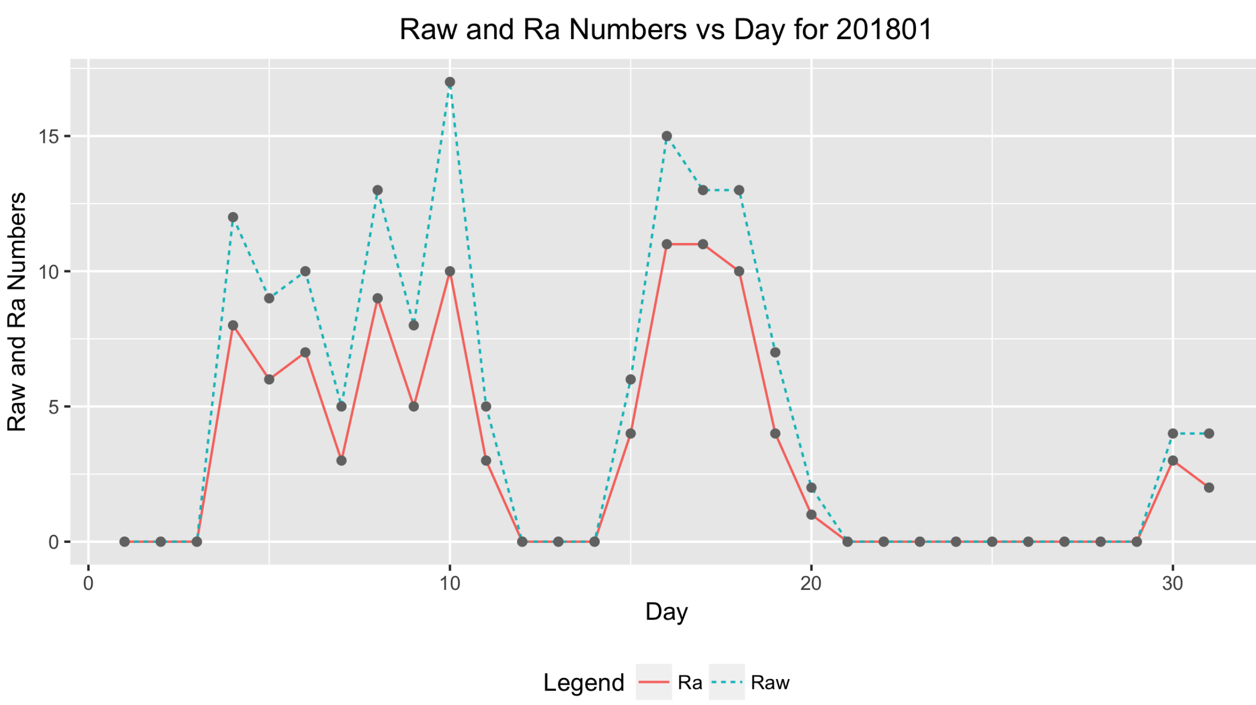

Figure 9: Raw Wolf and Ra numbers by day of the month by observer.

3.3 Sunspot Observers

Table 3 lists the observer code (obs), the number of observations submitted for January 2018, 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 60 and the total number of observations is 834.

Table 3: 201801 Number of observations by observer

Obs	NumObs	Name
AAX	19	Alexandre Amorim
AJV	17	J. Alonso
ARAG	30	Gema Araujo
ASA	30	Salvador Aguirre
BARH	6	Howard Barnes
BATR	4	Roberto Battaiola
BERJ	25	Jose Alberto Berdejo
BGAF	2	Gabriel Bandy
BMF	19	Michael Boschat
BRAD	24	David Branchett
BRAF	8	Raffaello Braga
BROB	24	Robert Brown
CHAG	23	German Morales Chavez
CIOA	20	Ioannis Chouinavas
CKB	17	Brian Cudnik
CNT	9	Dean Chantiles
CVJ	8	Jose Carvajal
DEMF	1	Frank Dempsey
DJOB	12	Jorge del Rosario
DROB	6	Bob Dudley
ERB	5	Bob Eramia
FERJ	9	Javier Ruiz Fernandez
FLET	20	Tom Fleming
FLF	4	Fredirico Luiz Funari
FTAA	4	Tadeusz Figiel
FUJK	24	K. Fujimori
HAYK	6	Kim Hay
HMQ	4	Mark Harris
HOWR	17	Rodney Howe
JDAC	10	David Jackson
JGE	6	Gerardo Jimenez Lopez
JPG	2	Penko Jordanov
KAPJ	19	John Kaplan
KNJS	31	James & Shirley Knight
KROL	20	Larry Krozel
LEVM	17	Monty Leventhal
LKR	4	Kristine Larsen
LRRA	16	Robert Little

Continued on next page

Table 3: 201801 Number of observations by observer

Obs	NumObs	Name
MCE	27	Etsuiku Mochizuki
MILJ	11	Jay Miller
MJAF	31	Juan Antonio Moreno Quesada
MJHA	28	John McCammon
MMAV	7	Marcelino Vazquez Munoz
MUDG	10	George Mudry
MWU	13	Walter Maluf
OATS	2	Susan Oatney
ONJ	2	John O'Neill
RLM	6	Mat Raymonde
SDOH	31	Solar Dynamics Obs - HMI
SIMC	1	Clyde Simpson
SMNA	3	Michael Stephanou
SNE	3	Neil Simmons
SONA	3	Andries Son
STAB	21	Brian Gordon-States
SUZM	25	Miyoshi Suzuki
TESD	22	David Teske
URBP	13	Piotr Urbanski
VARG	24	A. Gonzalo Vargas
VIDD	9	Daniel Vidican
WILW	16	William M. Wilson
Totals	834	60

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 10 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

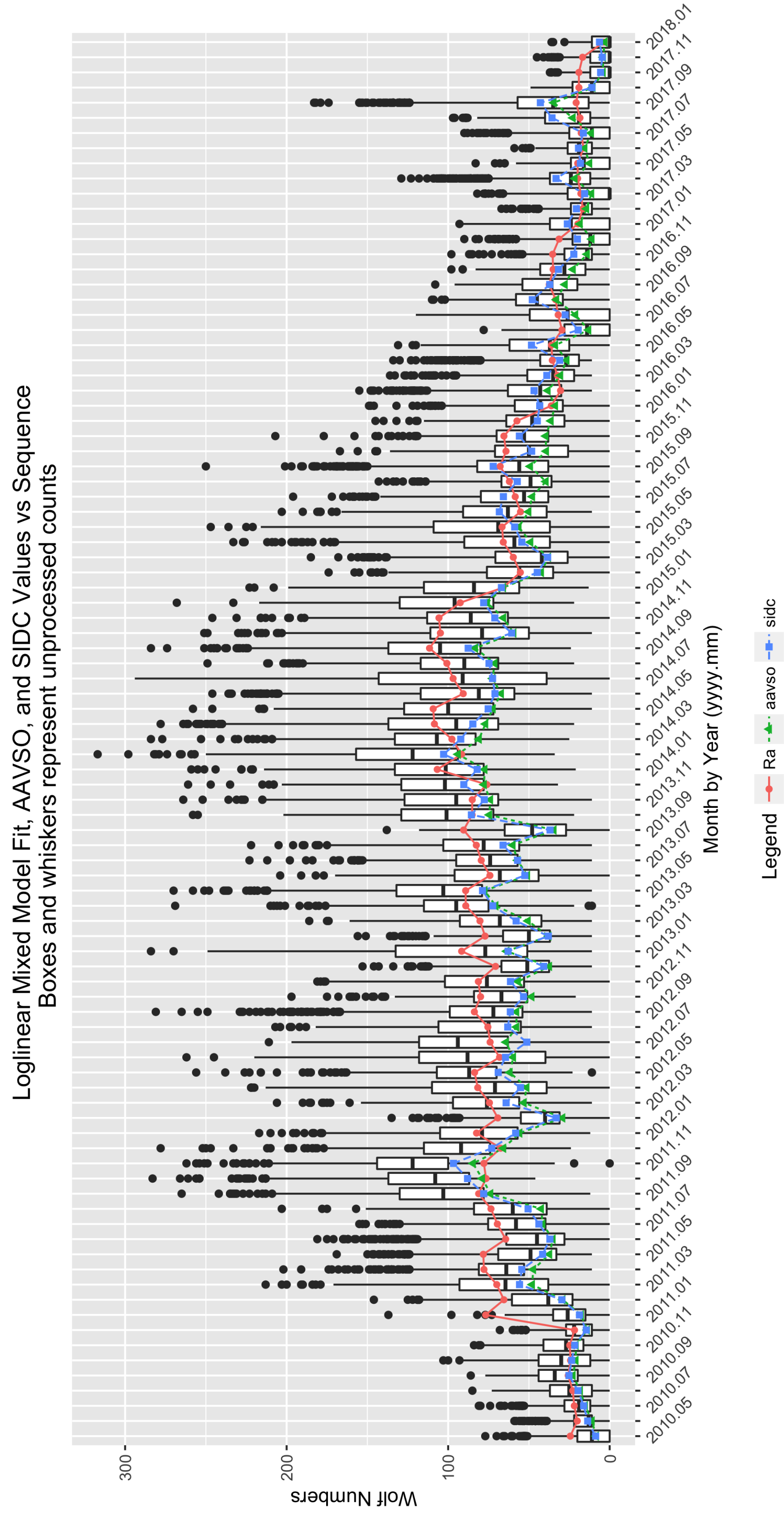

Figure 10: GLMM fitted data for R_a. AAVSO data: https://www.aavso.org/category/tags/solar-bulletin. SILSO data: WDC-SILSO, Royal Observatory of Belgium, Brussels