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
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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 Brenda Branchett observes the Sun

We are sad to inform you that AAVSO solar observer Brenda Branchett (BRAB) passed away on October 26, 2017, after a long illness. Brenda was a longtime sunspot observer, and had earned numerous AAVSO Solar Observer Awards for her observing. Figure 1 shows how Brenda's observations compare to all other AAVSO observers daily American Relative number. Brenda had an overall k - factor of .718, so her observations (Wolf numbers) are about 30 percent higher than the average AAVSO Ra.

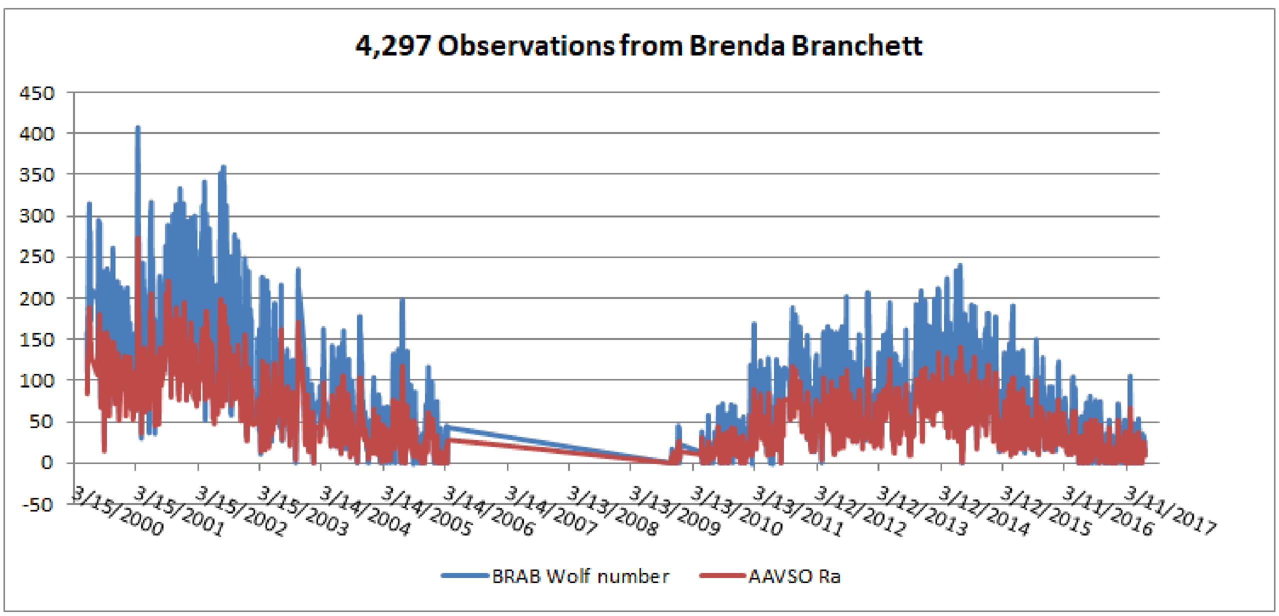

Figure 1: Brenda Branchett daily Wolf numbers and the AAVSO Ra from 2000 to 2017

The main activity of the AAVSO Solar Section is the monitoring and recording of sunspots from which the American Relative Sunspot Numbers (Ra) are computed. Please view the new Solar Observing Guide on the AAVSO Solar Section website: (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. 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/`) I bought one of these because an electrical engineer, Nathan Towne, who works at the NRAO Very Large Array in New Mexico has written Python software for it: (`http://myplace.frontier.com/~nathan56/sidmon/sidmon.html#equipment`) I put the SID loop antenna right into the mic input of the Xonar, no need for amplification (SuperSID or otherwise).

2.1 SID Records

October 2017 (Figure 2) The software makes some neat graphs. At this time Nathan's Python software only runs on Ubuntu 16.04, we are experimenting with other operating systems. Here's a day in October where there was only one M1 class flare (October, 20 which peaked at 2323 UT). No other flaring above B class flares occurred the rest of the month.

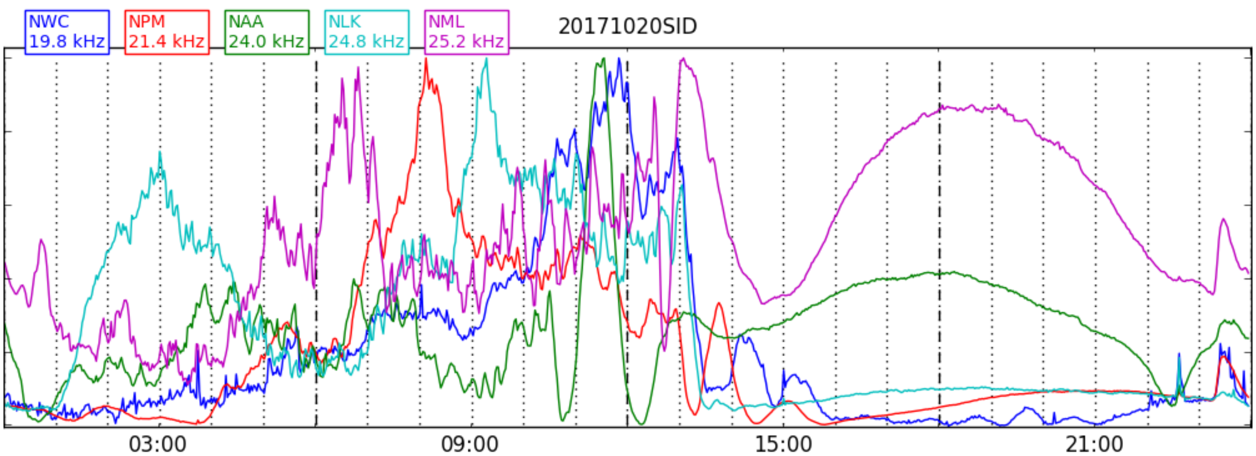

Figure 2: VLF recording using the sidmon.py software from Nathan Towne.

2.2 SID Observers

In October 2017 we have 17 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: 201709 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
S Oatney	A125	NML
J Karlovsky	A131	DHO NSY
R Green	A134	NWC
R Mrllak	A136	GQD NSY
S Aguirre	A138	NPM
G Silvis	A141	NAA
I Ryumshin	A142	ICV
R Rogge	A143	DHO GQD ICV
D Russel	A147	NAA 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.

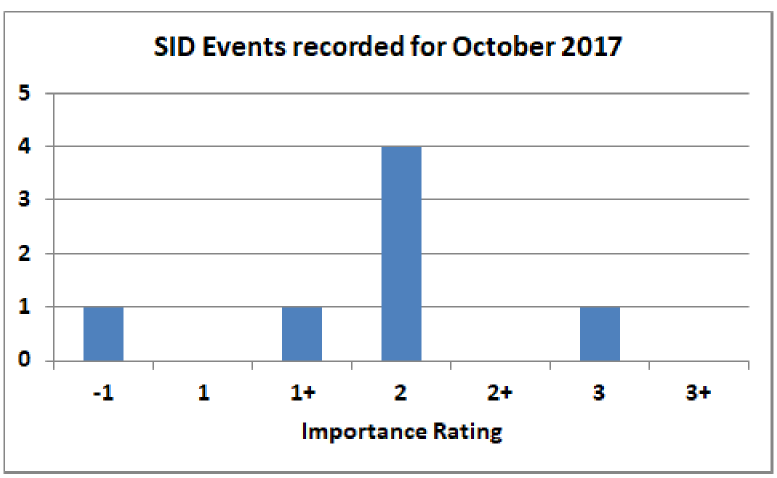

Figure 3: Solar Events Y-axis, Importance Rating X-axis.

2.3 Solar Flare Summary from GOES-15 Data

In October 2017, there were 36 solar flares measured by GOES-15 (see Figure 4). One M class, and 35 B class flares. A whole lot less flaring this month compared to last with 19 days of no reports from the GOES satellite.

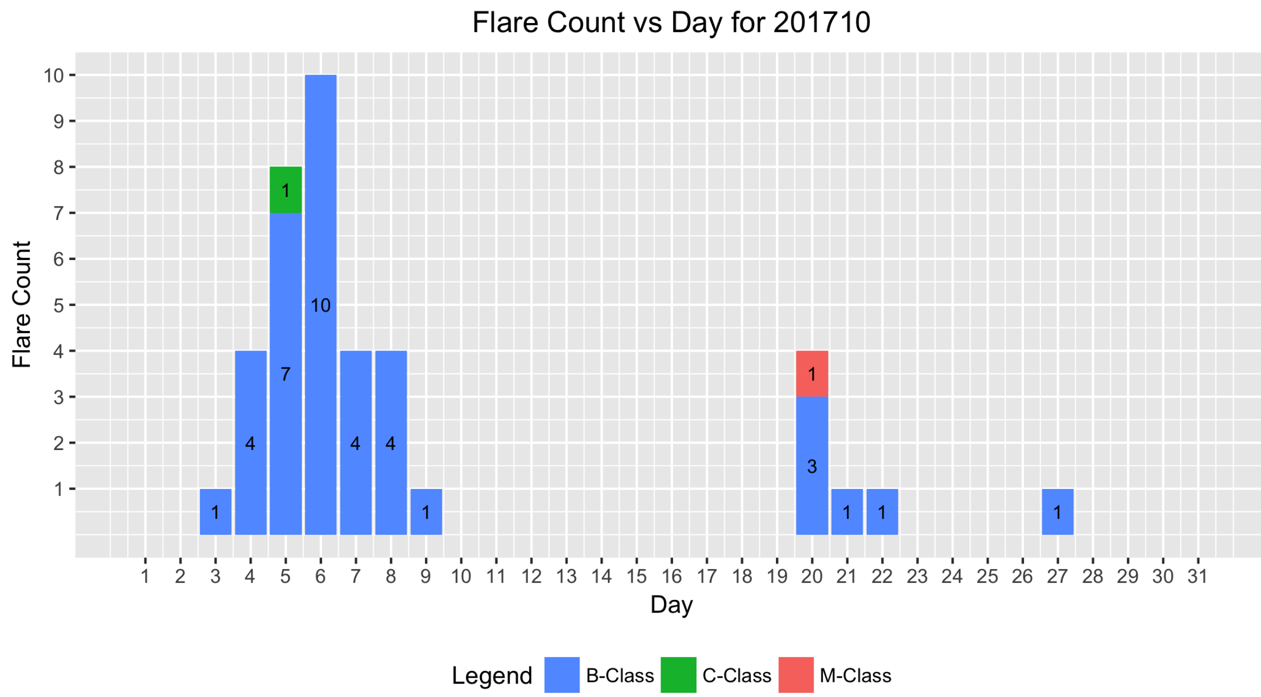

Figure 4: GOES - 15 XRA flares

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 October 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.

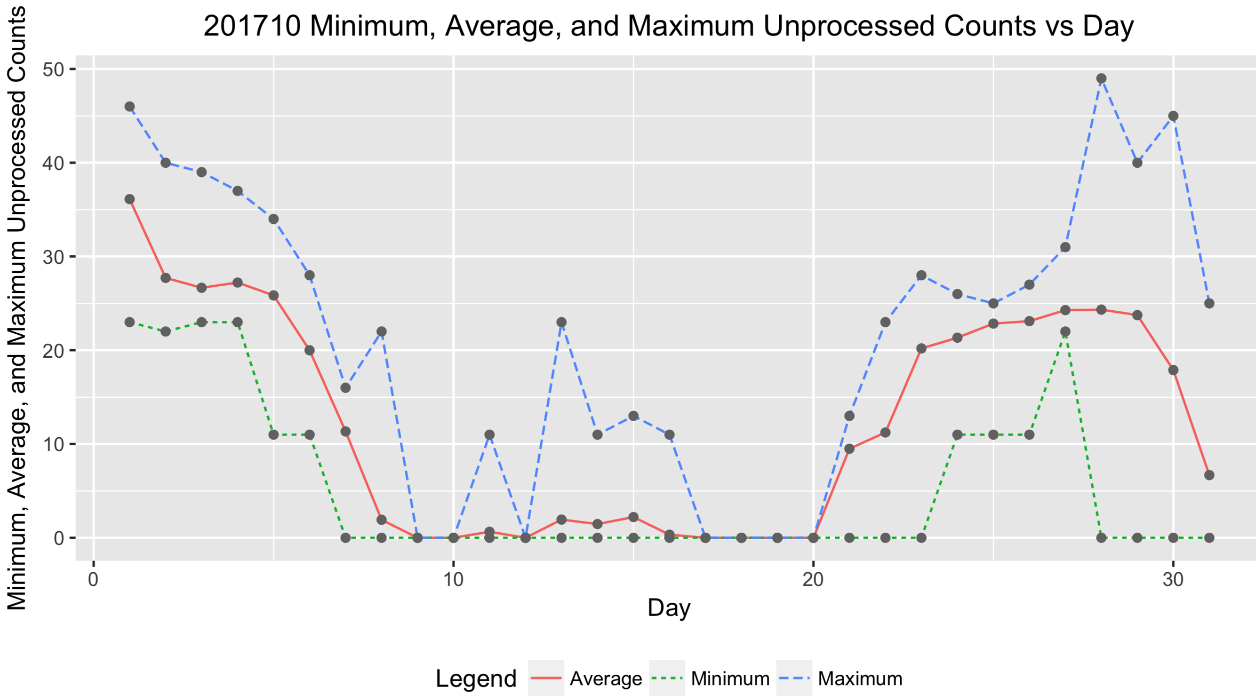

Figure 5: Raw average, minimum and maximum counts by day of the month by observer.

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: 201710 American Relative Sunspot Numbers (Ra)

Day	NumObs	Raw	Ra
1	33	37	31
2	32	27	22
3	39	27	23
4	40	28	23
5	34	27	22
6	33	20	16
7	32	11	10
8	37	3	2
9	32	0	0
10	36	0	0
11	34	1	0
12	33	0	0
13	35	2	1
14	30	2	1
15	33	3	2

Continued

Table 2: 201710 American Relative Sunspot Numbers (Ra)

Day	NumObs	Raw	Ra
16	33	0	0
17	33	0	0
18	35	0	0
19	31	0	0
20	32	0	0
21	26	10	8
22	34	11	10
23	31	20	16
24	29	20	17
25	32	23	20
26	28	23	20
27	32	24	21
28	33	25	22
29	28	23	18
30	27	18	13
31	35	9	6
Averges	32.6	12.7	10.5

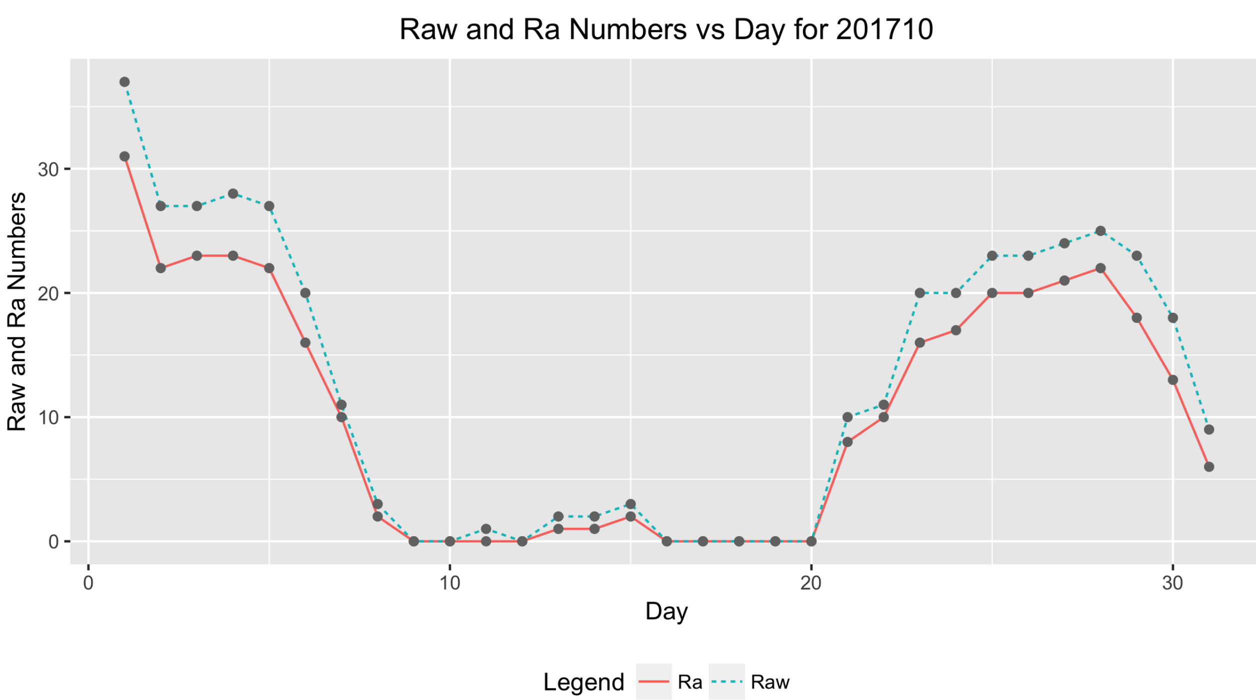

Figure 6: Raw Wolf and Ra numbers by day of the month by observer.

3.3 Sunspot Observers

Table 3 lists the observer code (obs), the number of observations submitted for October 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 64 and the total number of observations is 1012.

Table 3: 201710 Number of observations by observer

Obs	NumObs	Name
AAX	12	Alexandre Amorim
AJV	29	J. Alonso
ARAG	31	Gema Araujo
ASA	29	Salvador Aguirre
BARH	9	Howard Barnes
BATR	5	Roberto Battaiola
BERJ	28	Jose Alberto Berdejo
BMF	28	Michael Boschat
BRAB	13	Brenda Branchett
BRAF	14	Raffaello Braga
BROB	7	Robert Brown
BSAB	23	Santanu Basu
CHAG	29	German Morales Chavez
CIOA	18	Ioannis Chouinavas
CKB	29	Brian Cudnik
CNT	14	Dean Chantiles
CVJ	24	Jose Carvajal
DEMF	6	Frank Dempsey
DJOB	12	Jorge del Rosario
DROB	6	Bob Dudley
DUBF	27	Franky Dubois
FERJ	21	Javier Ruiz Fernandez
FLET	29	Tom Fleming
FLF	10	Fredirico Luiz Funari
FUJK	16	K. Fujimori
HAYK	7	Kim Hay
HIVB	3	Ivan Hajdinjak
HOWR	27	Rodney Howe
JDAC	16	David Jackson
JENS	1	Simon Jenner
JGE	7	Gerardo Jimenez Lopez
JPG	4	Penko Jordanov
KAPJ	11	John Kaplan
KNJS	31	James & Shirley Knight
KROL	18	Larry Krozel
LEVM	19	Monty Leventhal
LKR	8	Kristine Larsen
LRRA	25	Robert Little

Continued on next page

Table 3: 201710 Number of observations by observer

Obs	NumObs	Name
MARE	4	Enrico Mariani
MCE	14	Etsuiku Mochizuki
MILJ	16	Jay Miller
MJAF	31	Juan Antonio Moreno Quesada
MJHA	28	John McCammon
MUDG	11	George Mudry
MWU	16	Walter Maluf
OATS	4	Susan Oatney
ONJ	5	John O'Neill
RLM	12	Mat Raymonde
SDOH	31	Solar Dynamics Obs - HMI
SIMC	2	Clyde Simpson
SMNA	4	Michael Stephanou
SNE	1	Neil Simmons
SONA	11	Andries Son
SPIA	4	Piotr Skorupski
STAB	28	Brian Gordon-States
SUZM	14	Miyoshi Suzuki
TESD	29	David Teske
TPJB	7	Patrick Thibault
URBP	19	Piotr Urbanski
VARG	28	A. Gonzalo Vargas
VIDD	14	Dan Vidican
WCHD	5	Charles White
WILW	26	William M. Wilson
WRP	2	Russell Wheeler
Totals	1012	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 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

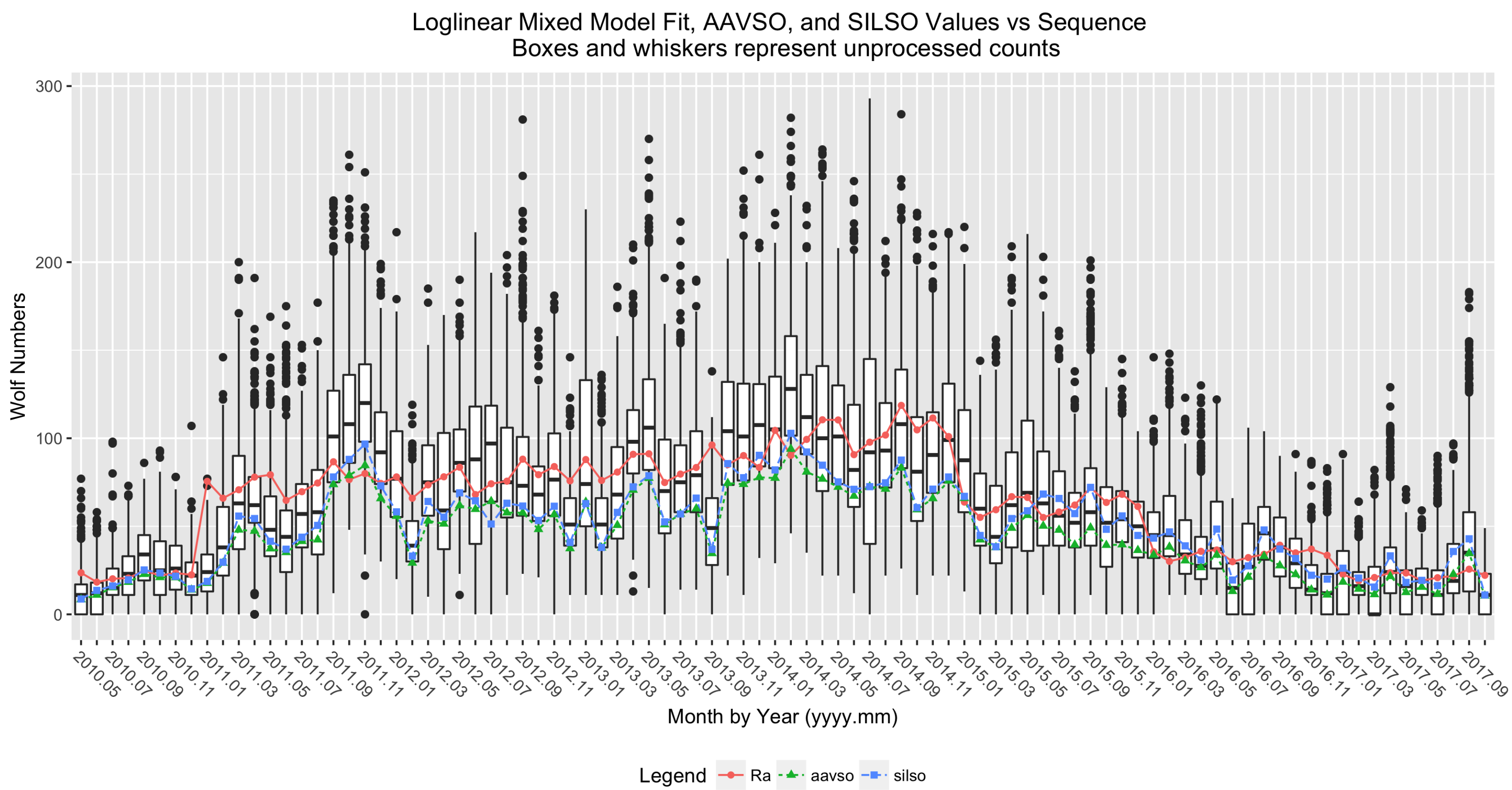

Figure 7: GLMM fitted data for R_a. AAVSO data: https://www.aavso.org/category/tags/solar-bulletin. SILSO data: WDC-SILSO, Royal Observatory of Belgium, Brussels