

**Monthly Report (00)**  
**2022.08 Data Set**

Wednesday 14<sup>th</sup> September, 2022

Prepared for

**Statistics for Physical and Engineering Sciences**

by

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## 1 Introduction

The process of 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 using the R statistics package (<http://www.R-project.org/>). This report is the portion of the analysis concerned with both the raw daily average counts and the data Accuracy, Consistency, and Completeness measures for a particular month. The checks are used to scrub or filter the data to assure only error-free data are used to determine the monthly sunspot number.

This report consists of four sections: the raw daily average counts (Section 2), the known data errors (Section 3), the processed counts using a Generalized Linear Mixed Model to produce the relative sunspot numbers (Section 4), and supporting information on the model construction (Section 5).

The raw daily average of counts consist of submitted counts from all observers who provided data in the particular month. These averaged counts are reported by the day of the month, and are either from data not scrubbed or corrected data. The table captions indicate which. The errors, if any, are reported according to type.

The Error Tables section contains reported errors on missing data, inconsistencies in year and month, inconsistencies in the reported day number (1-31), seeing coding errors, number of annual observations by observer, and inconsistencies between the reported Wolf number and the calculated Wolf number from the group counts and sunspot counts, among other errors that are given in that section.

The relative sunspot numbers  $R_a$  section contains the sunspot numbers after the submitted data are scrubbed and modeled by a Generalized Linear Mixed Model (GLMM). The GLMM is a statistical model that accounts for variation due to random effects and fixed effects. For the  $R_a$  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*.

The supporting information for the model is provided for clarification.

## 2 Raw Daily Average Counts

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 1 and Table 1.

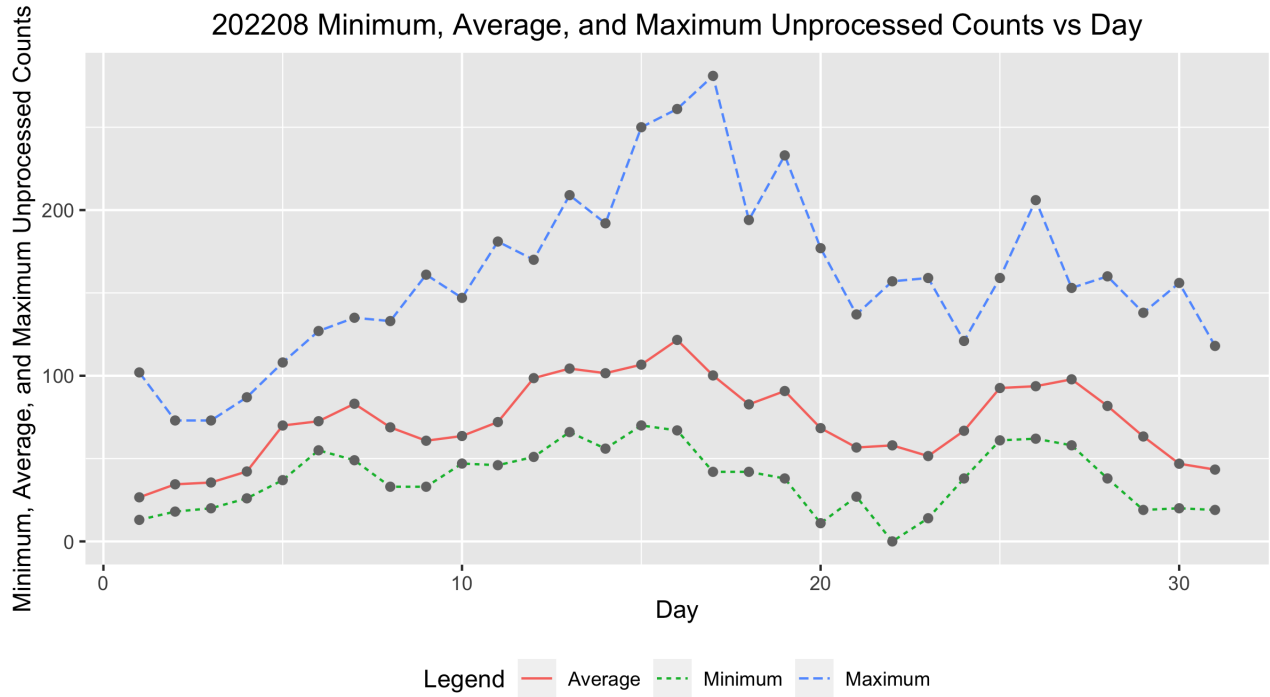


Figure 1: Raw average sunspot count by day of the month.

Table 1: 202208 Daily Raw Counts

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Day	Submissions	Minimum	Average	Maximum
1.0000	47.0000	13.0000	26.6170	102.0000
2.0000	45.0000	18.0000	34.4667	73.0000
3.0000	43.0000	20.0000	35.5581	73.0000
4.0000	43.0000	26.0000	42.2093	87.0000
5.0000	46.0000	37.0000	69.9565	108.0000
6.0000	47.0000	55.0000	72.5532	127.0000
7.0000	49.0000	49.0000	83.1020	135.0000
8.0000	51.0000	33.0000	68.8627	133.0000
9.0000	45.0000	33.0000	60.7778	161.0000
10.0000	43.0000	47.0000	63.6279	147.0000
11.0000	46.0000	46.0000	72.0435	181.0000
12.0000	51.0000	51.0000	98.5686	170.0000
13.0000	43.0000	66.0000	104.3256	209.0000
14.0000	49.0000	56.0000	101.5306	192.0000
15.0000	49.0000	70.0000	106.6939	250.0000
16.0000	40.0000	67.0000	121.6250	261.0000
17.0000	34.0000	42.0000	100.1765	281.0000
18.0000	37.0000	42.0000	82.7027	194.0000
19.0000	44.0000	38.0000	90.7727	233.0000
20.0000	47.0000	11.0000	68.3830	177.0000
21.0000	41.0000	27.0000	56.6829	137.0000
22.0000	38.0000	0.0000	57.9737	157.0000
23.0000	42.0000	14.0000	51.5238	159.0000
24.0000	45.0000	38.0000	66.7778	121.0000
25.0000	41.0000	61.0000	92.5854	159.0000
26.0000	41.0000	62.0000	93.6829	206.0000
27.0000	44.0000	58.0000	97.8409	153.0000
28.0000	42.0000	38.0000	81.7619	160.0000
29.0000	45.0000	19.0000	63.3333	138.0000
30.0000	41.0000	20.0000	46.9024	156.0000
31.0000	40.0000	19.0000	43.3500	118.0000

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### 3 Error Tables

Data are for the month of August 2022. No errors were found, and hence no errors are reported.

### 4 Relative Sunspot Numbers

All data errors, if any, have been corrected prior to determining the following relative sunspot numbers. A Generalized Linear Mixed Model (GLMM) was constructed to provide monthly sunspot numbers (see Table 2). The GLMM treats observer as a random effect, with year, month, seeing conditions, observer rank, and dual submission to both AAVSO and SILSO as fixed effects.

Figure 2 shows the monthly  $R_a$  numbers for the years and months (ym) in Table 2. The solid cyan curve that connects the cyan X's are the GLMM model estimates given in 2. 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 dashed red curve connecting the red O's are the SILSO values for the monthly sequence.

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 of the box plot represents the InterQuartile Range (IQR), which depicts from the 25<sup>th</sup> through the 75<sup>th</sup> quartiles. The lower and upper whiskers extend 1.5 times the IQR below the 25<sup>th</sup> quartile, and 1.5 times the IQR above the 75<sup>th</sup> quartile. The black circles below and above the whiskers traditionally are considered outliers, but with GLMM modeling, they are observations that comprise overdispersion. Overdispersion skews the counts data from a true Poisson distribution. The GLMM adjusts for this overdispersion.

Table 2: Year Month (ym) Relative Sunspot Numbers with 99% CI

ym	Ra	lci99	uci99	aavso	sidc
2008.12	2.7705	2.4232	3.1178	0.5000	1.0000
2009.01	5.1753	4.6388	5.7119	1.3000	1.3000
2009.02	4.6027	4.1119	5.0934	0.7000	1.2000
2009.03	6.1384	5.9106	6.3662	0.3000	0.6000
2009.04	6.9233	6.6891	7.1575	0.4000	1.2000
2009.05	7.1152	6.8480	7.3824	1.6000	2.9000
2009.06	6.3912	6.0799	6.7025	3.2000	6.3000
2009.07	6.3791	6.1304	6.6277	3.6000	5.5000
2009.08	6.6652	6.4203	6.9101	0.0000	0.0000
2009.09	7.3718	7.1226	7.6210	4.5000	7.1000
2009.10	6.8724	6.5225	7.2223	4.5000	7.7000
2009.11	7.0988	6.9054	7.2923	3.3000	6.9000
2009.12	7.0001	6.8021	7.1981	10.4000	16.3000
2010.01	19.5414	17.4123	21.6705	13.3000	19.5000
2010.02	15.7638	13.7175	17.8102	19.4000	28.5000

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Table 2: Year Month (ym) Relative Sunspot Numbers with 99% CI

ym	Ra	lci99	uci99	aavso	sidc
2010.03	17.7765	15.6649	19.8881	15.4000	24.0000
2010.04	19.7422	17.5149	21.9695	7.0000	10.4000
2010.05	23.6560	23.2373	24.0748	8.4000	8.7000
2010.06	19.9693	19.6305	20.3082	11.0000	13.6000
2010.07	21.8097	21.4849	22.1344	15.2000	16.1000
2010.08	21.9951	21.6246	22.3657	18.3000	19.6000
2010.09	25.3092	24.8844	25.7340	22.8000	25.2000
2010.10	23.9101	23.4872	24.3331	21.0000	23.5000
2010.11	25.1797	24.7197	25.6397	20.9000	21.6000
2010.12	23.9266	23.4466	24.4066	13.9000	14.5000
2011.01	70.1488	68.7196	71.5779	17.7000	18.7000
2011.02	61.5167	60.2211	62.8122	29.1000	29.6000
2011.03	67.2350	65.9440	68.5260	48.0000	55.8000
2011.04	75.7716	74.3647	77.1786	47.3000	54.4000
2011.05	77.8645	76.5318	79.1972	37.3000	41.5000
2011.06	65.6407	64.4799	66.8015	35.2000	37.0000
2011.07	70.7929	69.5796	72.0061	41.5000	43.8000
2011.08	72.1912	71.0220	73.3603	42.4000	50.5000
2011.09	81.8764	80.4420	83.3108	73.8000	78.0000
2011.10	77.3735	76.0588	78.6882	78.9000	88.0000
2011.11	81.3261	79.6439	83.0083	84.6000	96.7000
2011.12	75.8207	74.2706	77.3708	65.8000	73.0000
2012.01	75.3702	73.8834	76.8569	55.8000	58.2000
2012.02	64.9806	63.6500	66.3112	29.2000	33.1000
2012.03	71.7228	70.4492	72.9964	53.1000	64.1000
2012.04	79.4050	77.9859	80.8240	51.4000	55.2000
2012.05	83.3446	81.9494	84.7397	61.8000	69.0000
2012.06	69.6609	68.4710	70.8509	59.7000	64.5000
2012.07	75.7087	74.4566	76.9608	64.2000	51.3000
2012.08	74.3573	73.1461	75.5685	57.7000	63.1000
2012.09	84.7929	83.3126	86.2733	57.7000	61.5000
2012.10	80.9492	79.4578	82.4406	48.3000	53.3000
2012.11	85.2756	83.5551	86.9960	56.7000	61.4000
2012.12	79.5865	77.8553	81.3176	37.4000	40.8000
2013.01	83.6728	82.0637	85.2819	63.8000	62.9000
2013.02	72.2822	70.8162	73.7482	37.8000	38.0000
2013.03	77.3052	75.7182	78.8921	50.6000	57.9000
2013.04	86.5936	85.0506	88.1366	70.6000	72.4000
2013.05	88.7895	87.1836	90.3953	77.4000	78.7000

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Table 2: Year Month (ym) Relative Sunspot Numbers with 99% CI

ym	Ra	lci99	uci99	aavso	sidc
2013.06	75.7191	74.3602	77.0781	51.0000	52.5000
2013.07	81.2764	79.9465	82.6064	57.0000	57.0000
2013.08	81.5229	80.1895	82.8563	60.0000	66.0000
2013.09	91.4512	89.8010	93.1015	34.6000	36.9000
2013.10	86.2831	84.6662	87.8999	74.5000	85.6000
2013.11	89.3612	87.3278	91.3945	73.9000	77.6000
2013.12	85.7078	83.8677	87.5479	77.8000	90.3000
2014.01	97.6772	95.6083	99.7461	77.4000	82.0000
2014.02	86.1483	84.4267	87.8700	93.9000	102.8000
2014.03	94.2171	92.4815	95.9527	80.9000	92.2000
2014.04	105.6913	103.8155	107.5671	76.9000	84.7000
2014.05	108.9937	107.1164	110.8711	72.3000	75.2000
2014.06	92.8125	91.2224	94.4026	67.2000	71.0000
2014.07	99.2523	97.5715	100.9332	72.5000	72.5000
2014.08	99.6714	98.0985	101.2444	71.2000	74.7000
2014.09	113.0920	111.0738	115.1102	83.2000	87.6000
2014.10	106.2074	104.2375	108.1773	59.5000	60.6000
2014.11	111.1512	108.8199	113.4825	65.8000	71.1000
2014.12	104.1692	101.7522	106.5862	75.8000	78.0000
2015.01	60.3342	59.1243	61.5441	65.9000	67.0000
2015.02	52.0044	50.8431	53.1657	42.4000	44.8000
2015.03	57.6288	56.5660	58.6915	38.0000	38.4000
2015.04	64.2975	63.1341	65.4610	49.0000	54.4000
2015.05	66.4514	65.3420	67.5608	56.3000	58.8000
2015.06	56.3797	55.3673	57.3920	50.2000	68.3000
2015.07	59.7327	58.7216	60.7438	47.9000	65.8000
2015.08	61.1409	60.1209	62.1610	39.5000	57.2000
2015.09	68.6128	67.3703	69.8552	49.2000	72.1000
2015.10	64.8720	63.6224	66.1215	39.3000	48.3000
2015.11	68.5094	67.0171	70.0016	39.6000	55.9000
2015.12	64.5282	63.0971	65.9593	36.4000	44.8000
2016.01	33.0205	32.3329	33.7082	33.7000	43.3000
2016.02	28.5123	27.9181	29.1066	38.3000	46.8000
2016.03	31.1162	30.4952	31.7372	30.5000	38.9000
2016.04	34.5638	33.9050	35.2226	26.6000	30.9000
2016.05	35.8586	35.2049	36.5123	33.7000	48.4000
2016.06	30.1215	29.6085	30.6344	13.1000	19.5000
2016.07	32.5372	32.0167	33.0578	21.2000	27.5000
2016.08	32.9299	32.3528	33.5071	33.0000	47.9000

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Table 2: Year Month (ym) Relative Sunspot Numbers with 99% CI

ym	Ra	lci99	uci99	aavso	sidc
2016.09	37.8161	37.1279	38.5043	27.7000	37.1000
2016.10	35.4379	34.7573	36.1186	22.7000	31.7000
2016.11	37.0089	36.2364	37.7813	14.0000	22.2000
2016.12	35.2981	34.5407	36.0556	11.1000	20.0000
2017.01	17.8421	17.4658	18.2184	18.4000	26.2000
2017.02	15.4725	15.1321	15.8129	14.4000	20.6000
2017.03	17.0221	16.6976	17.3467	11.3000	15.5000
2017.04	19.0913	18.7547	19.4279	21.6000	33.2000
2017.05	19.5261	19.1890	19.8633	12.5000	18.1000
2017.06	16.3698	16.0977	16.6418	15.5000	19.3000
2017.07	17.7548	17.4706	18.0390	11.5000	16.3000
2017.08	17.9266	17.6138	18.2394	22.8000	35.7000
2017.09	20.9234	20.4865	21.3604	34.6000	42.9000
2017.10	19.0925	18.7000	19.4851	10.5000	11.0000
2017.11	19.8088	19.3885	20.2292	4.2000	5.6000
2017.12	18.7861	18.4991	19.0731	4.0000	4.6000
2018.01	4.9783	4.8721	5.0845	3.1000	6.3000
2018.02	4.2723	4.1687	4.3759	6.8000	11.8000
2018.03	4.6226	4.5292	4.7161	1.1000	1.2000
2018.04	5.1268	5.0240	5.2296	4.7000	7.5000
2018.05	5.3199	5.2205	5.4194	8.4000	14.0000
2018.06	4.4797	4.4009	4.5585	10.2000	13.6000
2018.07	4.8630	4.8081	4.9178	0.5000	1.7000
2018.08	4.8568	4.7739	4.9397	5.9000	9.5000
2018.09	5.4610	5.3589	5.5631	1.6000	2.9000
2018.10	5.2515	5.1484	5.3546	2.5000	5.6000
2018.11	5.4653	5.3511	5.5796	3.1000	4.2000
2018.12	5.2852	5.1820	5.3884	1.6000	2.3000
2019.01	3.2896	3.2269	3.3522	5.4000	2.3000
2019.02	2.8869	2.8304	2.9434	0.1000	1.2000
2019.03	3.0878	3.0354	3.1402	6.1000	12.1000
2019.04	3.4640	3.3990	3.5290	6.2000	9.3000
2019.05	3.4832	3.4229	3.5435	7.0000	11.9000
2019.06	2.9461	2.8968	2.9955	0.7000	1.5000
2019.07	3.1928	3.1456	3.2399	0.4000	2.2000
2019.08	3.2389	3.1911	3.2867	0.3000	0.8000
2019.09	3.7235	3.6655	3.7815	0.5000	1.0000
2019.10	3.4715	3.4126	3.5304	0.2000	0.5000
2019.11	3.6910	3.6204	3.7617	0.3000	0.6000

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Table 2: Year Month (ym) Relative Sunspot Numbers with 99% CI

ym	Ra	lci99	uci99	aavso	sidc
2019.12	3.4763	3.4077	3.5449	0.8000	1.0000
2020.01	7.2822	7.1398	7.4246	4.0000	5.3000
2020.02	6.3186	6.1919	6.4453	0.1000	0.0000
2020.03	6.8252	6.6978	6.9526	1.2000	1.5000
2020.04	7.6982	7.5719	7.8244	3.0000	5.1000
2020.05	7.8146	7.6926	7.9366	0.1000	0.4000
2020.06	6.6443	6.5431	6.7454	3.9000	6.4000
2020.07	7.1004	6.9969	7.2039	4.2000	7.7000
2020.08	7.0941	6.9964	7.1918	5.3000	7.8000
2020.09	8.1278	7.9984	8.2571	0.4000	0.9000
2020.10	7.7645	7.6374	7.8916	9.9000	13.6000
2020.11	8.1855	8.0547	8.3163	21.2000	33.1000
2020.12	7.7334	7.5958	7.8709	15.4000	19.8000
2021.01	25.4805	25.0287	25.9322	7.0000	15.8000
2021.02	22.4581	22.0583	22.8578	5.8000	10.7000
2021.03	24.4260	24.0387	24.8133	11.0000	17.2000
2021.04	27.5499	27.1214	27.9784	18.5000	28.8000
2021.05	28.2683	27.8636	28.6730	15.9000	22.9000
2021.06	23.9695	23.6202	24.3189	19.9000	24.1000
2021.07	25.5657	25.1713	25.9601	23.8000	35.6000
2021.08	26.3379	25.9311	26.7447	15.7000	19.5000
2021.09	29.9219	29.4502	30.3937	39.1000	52.5000
2021.10	28.7994	28.3212	29.2775	27.1000	37.0000
2021.11	30.2685	29.7836	30.7533	27.2000	35.1000
2021.12	29.3687	28.8441	29.8934	50.6000	69.0000
2022.01	71.2389	70.0587	72.4192	43.9000	62.0000
2022.02	62.6332	61.5592	63.7072	48.8000	60.5000
2022.03	68.7319	67.5683	69.8955	58.4000	80.6000
2022.04	75.0813	73.9635	76.1990	59.1000	83.9000
2022.05	79.4279	78.2112	80.6446	72.5000	0.4000
2022.06	65.6360	64.6502	66.6217	58.9000	0.4000
2022.07	71.5363	70.4180	72.6546	76.7000	102.5000
2022.08	72.0698	70.9548	73.1848	63.3000	86.0000

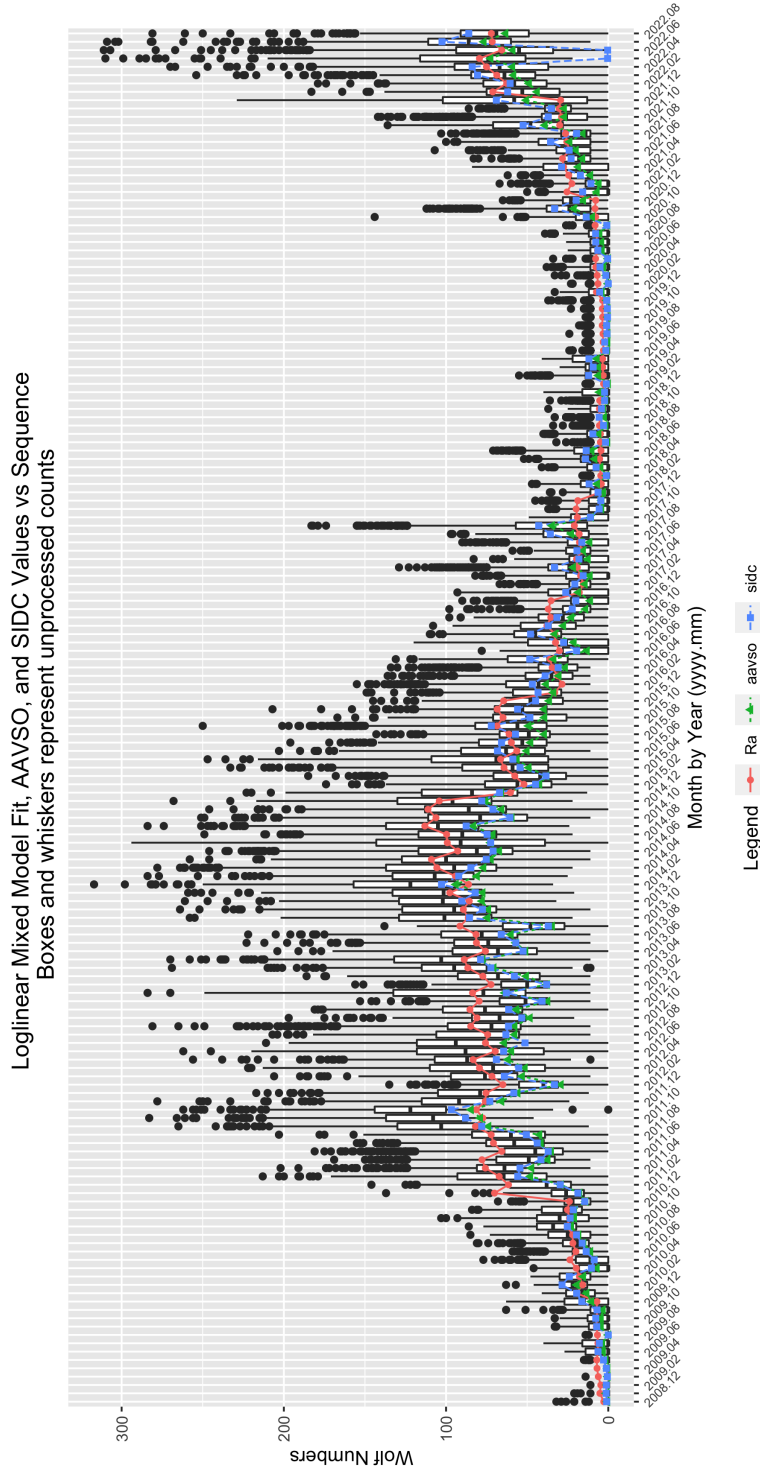


Figure 2: GLMM fitted data for  $R_a$ . AAVSO data: <https://www.aavso.org/category/tags/solar-bulletin>. SILSO data: WDC-SILSO, Royal Observatory of Belgium, Brussels

The GLMM parameter estimates and measures of importance in the determining the monthly  $R_a$  values are given in Table 3. The parameter estimates and levels of statistical significance are determined for the residual error size combined with the observer random effect error size. Thus, the parameter estimates are adjusted for the random effect of observer. The significance level is set at 0.05. Any  $\Pr(>|z|)$  values equal to or less than 0.05 are considered statistically significant.

The year effect levels are given as year2011, year2012, and year2013. The yearly effect is significant as  $\Pr(>|z|) < 0.05$ . So the year in which the observations are made is commensurate with the expected rise toward and anticipated sunspot number maximum. Similarly, the monthly effect, denoted as mon2 through mon12, is significant at the 0.05 level.

The seeing conditions account for a significant amount of deviation in sunspot numbers. The seeing conditions are denoted as seeF (Fair), seeG (Good), and seeP (Poor), and are significant at the 0.05 level. Therefore, seeing conditions influence the reported sunspot numbers, as intuition anticipates.

The level of observer experience (denoted r1000B through r5000H, which is least to most experience) is not significant at the 0.05 significance level. It therefore does not contribute to changes in the monthly sunspot numbers.

Whether an observer contributes counts to the SILSO as well as the AAVSO (silsoy) is not significant at the 0.05 level, and hence we conclude that those observers who contribute to both institutions tend to differ from those observers contributing only to the AAVSO.

## 5 Supporting Information

Table 3: 202208 Parameter Estimates

	Estimate	Std. Error	t-value	Pr(> t )
(Intercept)	1.2533	0.3161	3.9646	0.0001
seeF	-0.2248	0.0054	-41.2897	0.0000
seeG	-0.1214	0.0048	-25.5366	0.0000
seeM	-0.1908	0.0244	-7.8126	0.0000
seeP	-0.3228	0.0078	-41.2560	0.0000
sidc1	0.0492	0.0146	3.3713	0.0007
year2009	0.7203	0.3176	2.2681	0.0233
year2010	1.9541	0.3154	6.1963	0.0000
year2011	3.0961	0.3153	9.8207	0.0000
year2012	3.1366	0.3153	9.9492	0.0000
year2013	3.2322	0.3153	10.2526	0.0000
year2014	3.4303	0.3153	10.8811	0.0000
year2015	2.9463	0.3153	9.3454	0.0000
year2016	2.3299	0.3153	7.3897	0.0000
year2017	1.7188	0.3153	5.4508	0.0000
year2018	0.4345	0.3156	1.3766	0.1686
year2019	0.0170	0.3158	0.0537	0.9572
year2020	0.8223	0.3155	2.6066	0.0091
year2021	2.1018	0.3153	6.6658	0.0000
year2022	3.0725	0.3153	9.7445	0.0000
mon2	-0.1375	0.0086	-15.9905	0.0000
mon3	-0.0546	0.0080	-6.7925	0.0000
mon4	0.0487	0.0077	6.2838	0.0000
mon5	0.0734	0.0076	9.6690	0.0000
mon6	-0.0977	0.0079	-12.3529	0.0000
mon7	-0.0294	0.0077	-3.8378	0.0001
mon8	-0.0175	0.0076	-2.2991	0.0215
mon9	0.1179	0.0079	15.0161	0.0000
mon10	0.0626	0.0081	7.7528	0.0000
mon11	0.1214	0.0083	14.5620	0.0000
mon12	0.0705	0.0084	8.3971	0.0000

Table 4: 202208 Summary of Sunspot Numbers

year	mon	day	obs	sidc
Min. :2008	Min. : 1.000	Min. : 0.00	Length:159725	Min. :0.0000
1st Qu.:2013	1st Qu.: 4.000	1st Qu.: 8.00	Class :character	1st Qu.:0.0000
Median :2016	Median : 7.000	Median :16.00	Mode :character	Median :0.0000
Mean :2016	Mean : 6.544	Mean :15.72		Mean :0.2465
3rd Qu.:2019	3rd Qu.: 9.000	3rd Qu.:23.00		3rd Qu.:0.0000
Max. :2022	Max. :12.000	Max. :31.00		Max. :1.0000

Table 5: 202208 Summary of Sunspot Numbers

g	s	w	see	method
Min. : 0.000	Min. : 0.00	Min. : 0.00	Length:159725	Length:159725
1st Qu.: 0.000	1st Qu.: 0.00	1st Qu.: 0.00	Class :character	Class :character
Median : 2.000	Median : 8.00	Median : 30.00	Mode :character	Mode :character
Mean : 2.763	Mean : 15.93	Mean : 43.56		
3rd Qu.: 4.000	3rd Qu.: 23.00	3rd Qu.: 69.00		
Max. :19.000	Max. :204.00	Max. :317.00		

Table 6: 202208 Summary of Sunspot Numbers

inst	filter	unit
Length:159725	Length:159725	Length:159725
Class :character	Class :character	Class :character
Mode :character	Mode :character	Mode :character

Table 7: 202208 Summary of Sunspot Numbers

aperture	eyep	foclen	mag
Min. : 0.0	Min. : 0.00	Min. : 0.0	Min. : 0.0
1st Qu.: 60.0	1st Qu.: 5.00	1st Qu.: 60.0	1st Qu.: 40.0
Median : 80.0	Median : 14.00	Median : 900.0	Median : 57.0
Mean : 92.1	Mean : 36.13	Mean : 889.8	Mean : 180.4
3rd Qu.: 104.0	3rd Qu.: 23.00	3rd Qu.:1200.0	3rd Qu.: 75.0
Max. :1524.0	Max. :2010.00	Max. :9990.0	Max. :4591.0

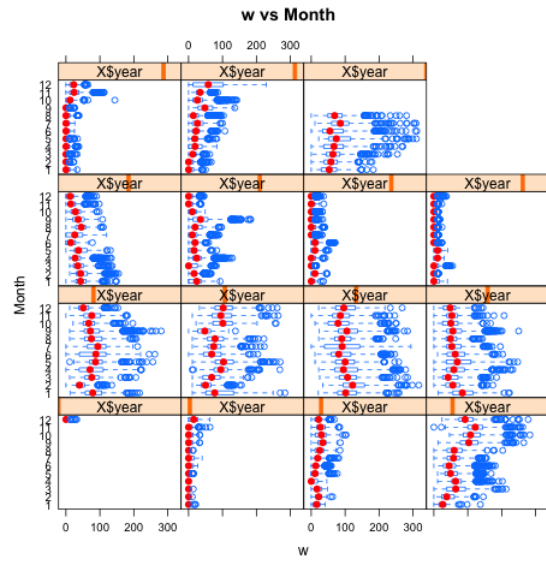
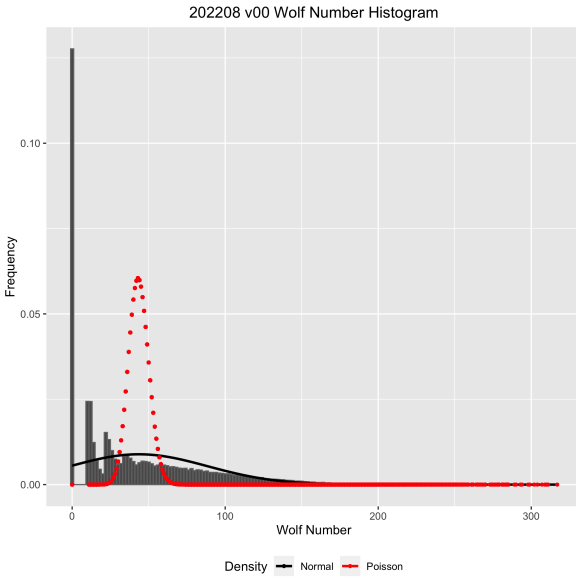


Figure 3: Box plots of raw Wolf number (w) by observer rank.

Figure 4: Box plots of raw Wolf number (w) by month and year.

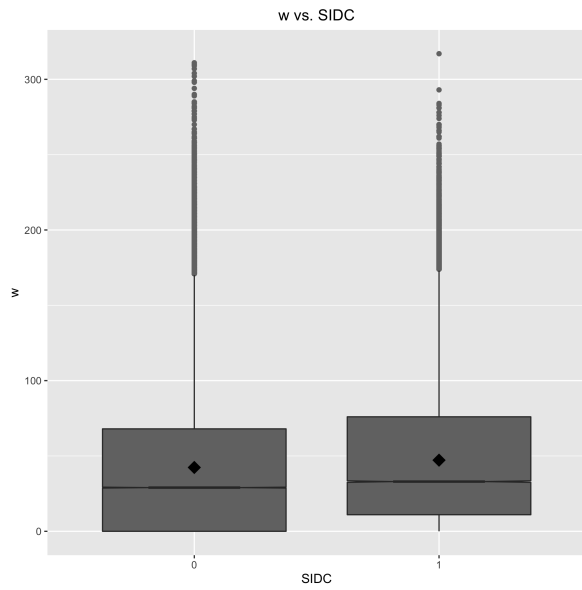
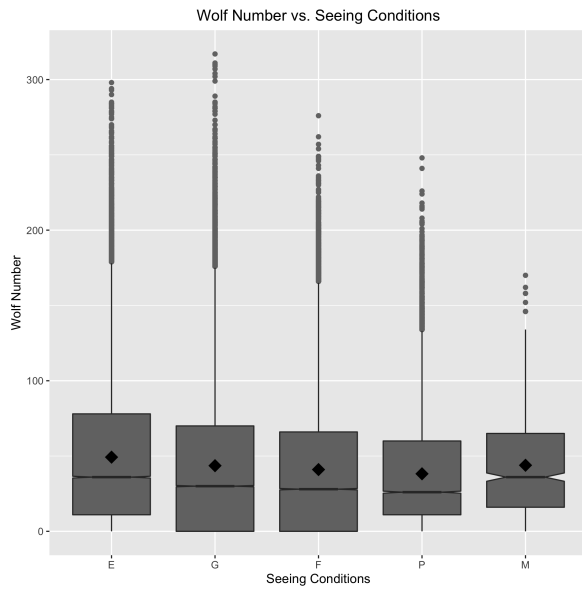


Figure 5: Box plots of raw Wolf number (w) by seeing condition.

Figure 6: Box plots of raw Wolf number (w) by organization.

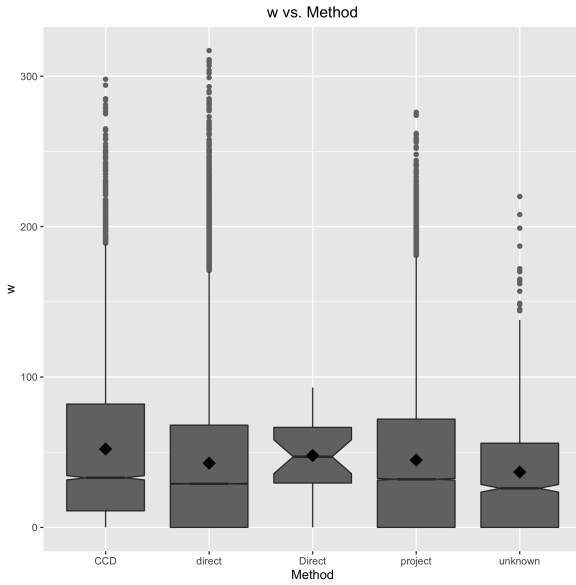


Figure 7: Box plots of raw Wolf number ( $w$ ) by observer rank.

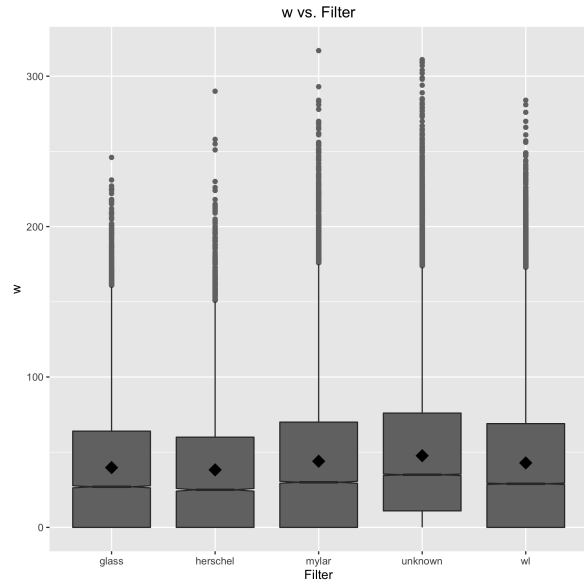


Figure 8: Box plots of raw Wolf number ( $w$ ) by month and year.

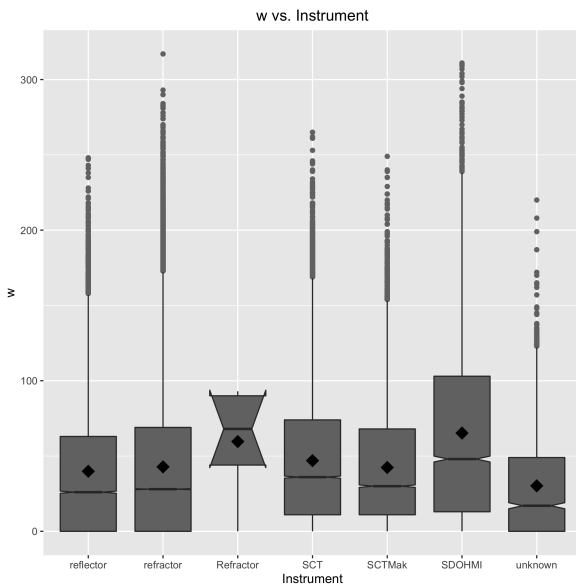


Figure 9: Box plots of raw Wolf number ( $w$ ) by seeing condition.

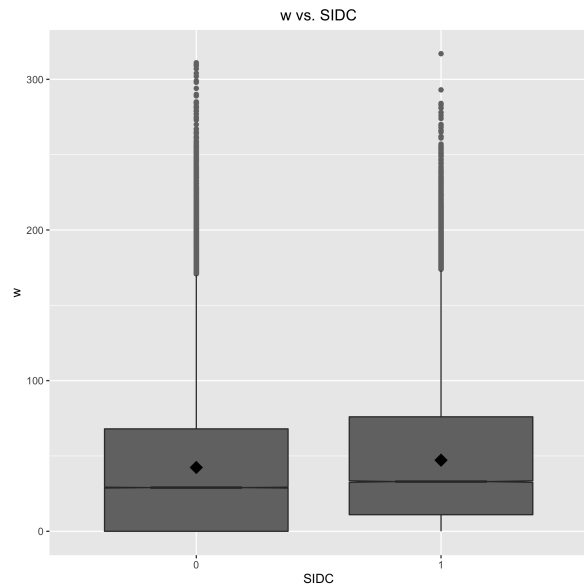


Figure 10: Box plots of raw Wolf number ( $w$ ) by organization.



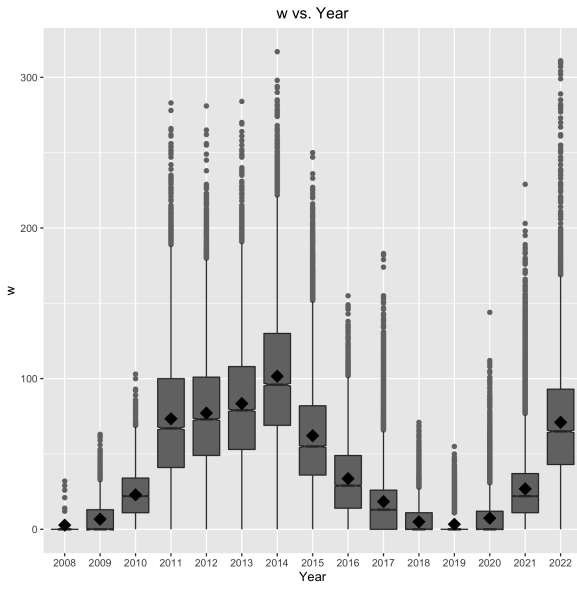


Figure 11: Box plots of raw Wolf number ( $w$ ) by year.

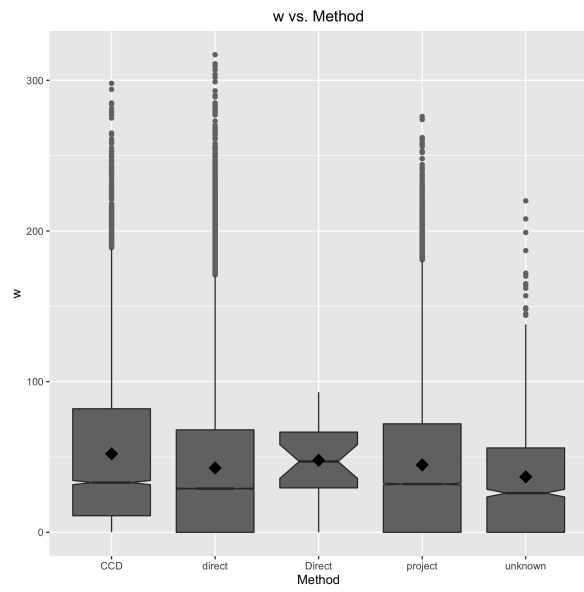


Figure 12: Box plots of raw Wolf number ( $w$ ) by observing method.