

Monthly Report (00)

2023.04 Data Set

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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.

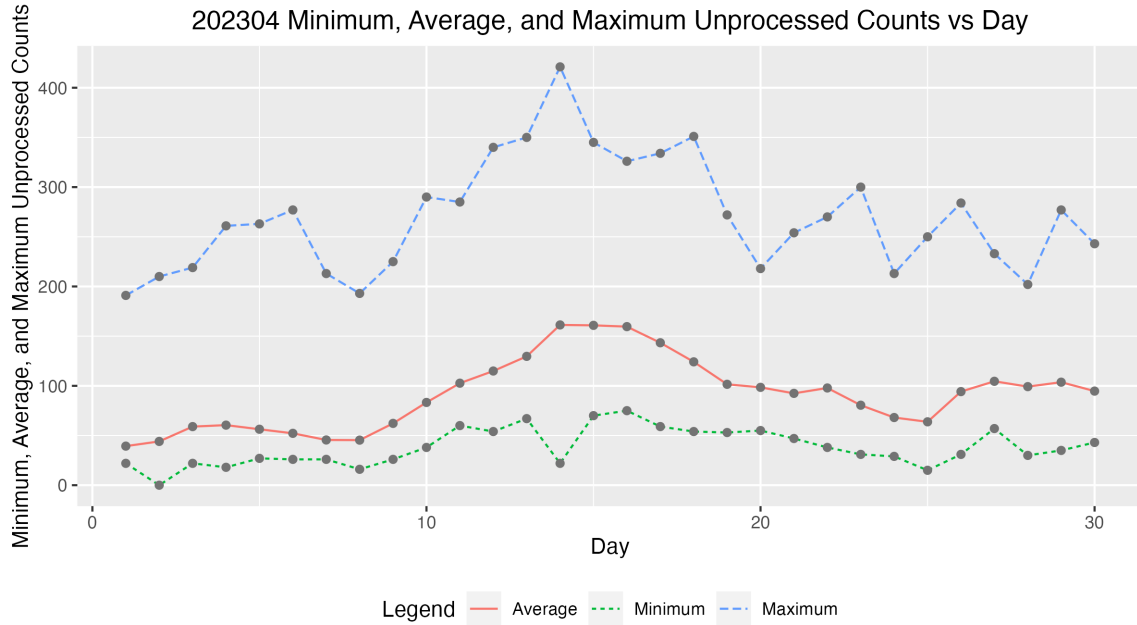


Figure 1: Raw average sunspot count by day of the month.

Table 1: 202304 Daily Raw Counts

Day	Submissions	Minimum	Average	Maximum
1.0000	34.0000	22.0000	39.3235	191.0000
2.0000	36.0000	0.0000	44.0556	210.0000
3.0000	35.0000	22.0000	58.9714	219.0000
4.0000	35.0000	18.0000	60.4571	261.0000
5.0000	29.0000	27.0000	56.3103	263.0000
6.0000	31.0000	26.0000	52.1935	277.0000
7.0000	29.0000	26.0000	45.5172	213.0000
8.0000	36.0000	16.0000	45.3611	193.0000
9.0000	38.0000	26.0000	62.2105	225.0000
10.0000	42.0000	38.0000	83.2857	290.0000
11.0000	35.0000	60.0000	102.6571	285.0000
12.0000	32.0000	54.0000	114.9062	340.0000
13.0000	38.0000	67.0000	129.6579	350.0000
14.0000	34.0000	22.0000	161.2941	421.0000
15.0000	30.0000	70.0000	160.8667	345.0000
16.0000	36.0000	75.0000	159.5833	326.0000
17.0000	38.0000	59.0000	143.3421	334.0000
18.0000	35.0000	54.0000	124.1429	351.0000
19.0000	39.0000	53.0000	101.5385	272.0000
20.0000	36.0000	55.0000	98.4722	218.0000
21.0000	31.0000	47.0000	92.4194	254.0000
22.0000	26.0000	38.0000	97.8462	270.0000
23.0000	28.0000	31.0000	80.5000	300.0000
24.0000	29.0000	29.0000	68.1034	213.0000
25.0000	37.0000	15.0000	63.7838	250.0000
26.0000	31.0000	31.0000	94.1935	284.0000
27.0000	30.0000	57.0000	104.5667	233.0000
28.0000	35.0000	30.0000	99.2000	202.0000
29.0000	27.0000	35.0000	103.6667	277.0000
30.0000	29.0000	43.0000	94.6897	243.0000

3 Error Tables

Data are for the month of April 2023. 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 25th through the 75th quartiles. The lower and upper whiskers extend 1.5 times the IQR below the 25th quartile, and 1.5 times the IQR above the 75th 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	2.4236	3.1173	0.5000	1.0000
2009.01	5.2494	4.7059	5.7928	1.3000	1.3000
2009.02	4.6969	4.1964	5.1973	0.7000	1.2000
2009.03	6.0965	5.8715	6.3215	0.3000	0.6000
2009.04	6.5982	6.3770	6.8194	0.4000	1.2000
2009.05	7.0569	6.7909	7.3230	1.6000	2.9000
2009.06	6.3560	6.0489	6.6631	3.2000	6.3000
2009.07	6.3328	6.0857	6.5799	3.6000	5.5000
2009.08	6.6324	6.3886	6.8763	0.0000	0.0000
2009.09	7.3271	7.0810	7.5732	4.5000	7.1000
2009.10	6.8528	6.5032	7.2024	4.5000	7.7000
2009.11	6.8656	6.6725	7.0587	3.3000	6.9000
2009.12	7.3262	7.1099	7.5424	10.4000	16.3000
2010.01	19.9252	17.7619	22.0885	13.3000	19.5000
2010.02	16.1417	14.0533	18.2300	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	17.7938	15.6799	19.9076	15.4000	24.0000
2010.04	18.9144	16.7810	21.0479	7.0000	10.4000
2010.05	23.5360	23.1008	23.9712	8.4000	8.7000
2010.06	19.9139	19.5564	20.2714	11.0000	13.6000
2010.07	21.7515	21.4022	22.1008	15.2000	16.1000
2010.08	21.9402	21.5424	22.3381	18.3000	19.6000
2010.09	25.2868	24.8276	25.7459	22.8000	25.2000
2010.10	24.0245	23.5610	24.4880	21.0000	23.5000
2010.11	24.3984	23.9303	24.8665	20.9000	21.6000
2010.12	25.1096	24.5779	25.6413	13.9000	14.5000
2011.01	71.5162	69.9867	73.0457	17.7000	18.7000
2011.02	63.0751	61.6716	64.4786	29.1000	29.6000
2011.03	67.2021	65.8442	68.5600	48.0000	55.8000
2011.04	72.8269	71.3641	74.2897	47.3000	54.4000
2011.05	77.7554	76.3340	79.1768	37.3000	41.5000
2011.06	65.5492	64.3261	66.7722	35.2000	37.0000
2011.07	70.5858	69.3272	71.8444	41.5000	43.8000
2011.08	72.0038	70.7813	73.2264	42.4000	50.5000
2011.09	81.9193	80.4019	83.4366	73.8000	78.0000
2011.10	77.6709	76.2797	79.0622	78.9000	88.0000
2011.11	78.8811	77.2075	80.5547	84.6000	96.7000
2011.12	79.5472	77.8817	81.2126	65.8000	73.0000
2012.01	76.9036	75.3380	78.4692	55.8000	58.2000
2012.02	66.6997	65.2834	68.1159	29.2000	33.1000
2012.03	71.6860	70.3722	72.9999	53.1000	64.1000
2012.04	76.0686	74.6409	77.4964	51.4000	55.2000
2012.05	83.1452	81.6827	84.6078	61.8000	69.0000
2012.06	69.5936	68.3505	70.8367	59.7000	64.5000
2012.07	75.5751	74.2637	76.8865	64.2000	51.3000
2012.08	74.1566	72.8865	75.4267	57.7000	63.1000
2012.09	84.7293	83.2010	86.2576	57.7000	61.5000
2012.10	81.2342	79.6841	82.7843	48.3000	53.3000
2012.11	82.8484	81.1334	84.5633	56.7000	61.4000
2012.12	83.4601	81.6097	85.3105	37.4000	40.8000
2013.01	85.3312	83.6476	87.0147	63.8000	62.9000
2013.02	74.1141	72.5646	75.6636	37.8000	38.0000
2013.03	77.2179	75.5949	78.8409	50.6000	57.9000
2013.04	82.9589	81.4276	84.4903	70.6000	72.4000
2013.05	88.5441	86.8743	90.2139	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	75.6160	74.1954	77.0366	51.0000	52.5000
2013.07	81.1788	79.7864	82.5712	57.0000	57.0000
2013.08	81.3784	79.9903	82.7665	60.0000	66.0000
2013.09	91.4090	89.7064	93.1115	34.6000	36.9000
2013.10	86.5608	84.8888	88.2329	74.5000	85.6000
2013.11	86.8679	84.8288	88.9071	73.9000	77.6000
2013.12	89.9394	87.9749	91.9040	77.8000	90.3000
2014.01	99.6782	97.5239	101.8326	77.4000	82.0000
2014.02	88.4917	86.6589	90.3245	93.9000	102.8000
2014.03	94.2124	92.4258	95.9991	80.9000	92.2000
2014.04	101.3677	99.4996	103.2357	76.9000	84.7000
2014.05	108.7837	106.8471	110.7203	72.3000	75.2000
2014.06	92.7825	91.1232	94.4419	67.2000	71.0000
2014.07	99.1861	97.4329	100.9393	72.5000	72.5000
2014.08	99.4926	97.8593	101.1259	71.2000	74.7000
2014.09	113.0796	110.9836	115.1756	83.2000	87.6000
2014.10	106.5306	104.4988	108.5624	59.5000	60.6000
2014.11	107.9862	105.6526	110.3198	65.8000	71.1000
2014.12	109.1057	106.5519	111.6595	75.8000	78.0000
2015.01	61.6092	60.3559	62.8625	65.9000	67.0000
2015.02	53.4953	52.2600	54.7306	42.4000	44.8000
2015.03	57.7268	56.6306	58.8230	38.0000	38.4000
2015.04	61.7884	60.6240	62.9528	49.0000	54.4000
2015.05	66.3429	65.1988	67.4871	56.3000	58.8000
2015.06	56.2427	55.2185	57.2670	50.2000	68.3000
2015.07	59.5064	58.4938	60.5190	47.9000	65.8000
2015.08	60.8880	59.8657	61.9104	39.5000	57.2000
2015.09	68.4971	67.2488	69.7455	49.2000	72.1000
2015.10	64.9909	63.7331	66.2488	39.3000	48.3000
2015.11	66.4484	64.9875	67.9092	39.6000	55.9000
2015.12	67.7433	66.2241	69.2624	36.4000	44.8000
2016.01	33.7188	33.0107	34.4269	33.7000	43.3000
2016.02	29.2706	28.6559	29.8853	38.3000	46.8000
2016.03	31.1286	30.5018	31.7554	30.5000	38.9000
2016.04	33.1271	32.4905	33.7638	26.6000	30.9000
2016.05	35.7200	35.0643	36.3758	33.7000	48.4000
2016.06	30.0471	29.5306	30.5636	13.1000	19.5000
2016.07	32.4563	31.9319	32.9807	21.2000	27.5000
2016.08	32.8096	32.2286	33.3906	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	37.7640	37.0701	38.4578	27.7000	37.1000
2016.10	35.5252	34.8372	36.2133	22.7000	31.7000
2016.11	35.9226	35.1673	36.6780	14.0000	22.2000
2016.12	37.0877	36.2857	37.8896	11.1000	20.0000
2017.01	18.1705	17.7838	18.5571	18.4000	26.2000
2017.02	15.8330	15.4818	16.1842	14.4000	20.6000
2017.03	16.9645	16.6381	17.2909	11.3000	15.5000
2017.04	18.2291	17.9047	18.5535	21.6000	33.2000
2017.05	19.3986	19.0605	19.7367	12.5000	18.1000
2017.06	16.2732	16.0013	16.5451	15.5000	19.3000
2017.07	17.6584	17.3741	17.9427	11.5000	16.3000
2017.08	17.8123	17.4999	18.1248	22.8000	35.7000
2017.09	20.8268	20.3897	21.2640	34.6000	42.9000
2017.10	19.0679	18.6745	19.4613	10.5000	11.0000
2017.11	19.1734	18.7648	19.5819	4.2000	5.6000
2017.12	19.6870	19.3851	19.9889	4.0000	4.6000
2018.01	5.0777	4.9685	5.1869	3.1000	6.3000
2018.02	4.3834	4.2768	4.4899	6.8000	11.8000
2018.03	4.6233	4.5295	4.7170	1.1000	1.2000
2018.04	4.9123	4.8136	5.0111	4.7000	7.5000
2018.05	5.3020	5.2030	5.4010	8.4000	14.0000
2018.06	4.4682	4.3895	4.5469	10.2000	13.6000
2018.07	4.8548	4.8000	4.9095	0.5000	1.7000
2018.08	4.8426	4.7595	4.9257	5.9000	9.5000
2018.09	5.4565	5.3541	5.5588	1.6000	2.9000
2018.10	5.2633	5.1601	5.3666	2.5000	5.6000
2018.11	5.3044	5.1933	5.4156	3.1000	4.2000
2018.12	5.5474	5.4390	5.6558	1.6000	2.3000
2019.01	3.3630	3.2988	3.4271	5.4000	2.3000
2019.02	2.9625	2.9042	3.0209	0.1000	1.2000
2019.03	3.0913	3.0388	3.1439	6.1000	12.1000
2019.04	3.3202	3.2577	3.3827	6.2000	9.3000
2019.05	3.4731	3.4126	3.5335	7.0000	11.9000
2019.06	2.9391	2.8895	2.9887	0.7000	1.5000
2019.07	3.1870	3.1397	3.2342	0.4000	2.2000
2019.08	3.2307	3.1829	3.2786	0.3000	0.8000
2019.09	3.7173	3.6590	3.7756	0.5000	1.0000
2019.10	3.4790	3.4198	3.5381	0.2000	0.5000
2019.11	3.5873	3.5185	3.6562	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	3.6552	3.5826	3.7279	0.8000	1.0000
2020.01	7.4445	7.2985	7.5904	4.0000	5.3000
2020.02	6.4888	6.3585	6.6191	0.1000	0.0000
2020.03	6.8343	6.7065	6.9621	1.2000	1.5000
2020.04	7.3883	7.2670	7.5095	3.0000	5.1000
2020.05	7.7914	7.6702	7.9126	0.1000	0.4000
2020.06	6.6344	6.5327	6.7362	3.9000	6.4000
2020.07	7.0895	6.9851	7.1939	4.2000	7.7000
2020.08	7.0804	6.9819	7.1789	5.3000	7.8000
2020.09	8.1196	7.9892	8.2499	0.4000	0.9000
2020.10	7.7822	7.6538	7.9107	9.9000	13.6000
2020.11	7.9395	7.8103	8.0687	21.2000	33.1000
2020.12	8.1196	7.9733	8.2659	15.4000	19.8000
2021.01	26.0035	25.5386	26.4685	7.0000	15.8000
2021.02	23.0609	22.6494	23.4725	5.8000	10.7000
2021.03	24.4511	24.0630	24.8391	11.0000	17.2000
2021.04	26.5451	26.0958	26.9943	18.5000	28.8000
2021.05	28.3099	27.8724	28.7475	15.9000	22.9000
2021.06	23.9511	23.5727	24.3296	19.9000	24.1000
2021.07	25.5307	25.1065	25.9549	23.8000	35.6000
2021.08	26.3628	25.9281	26.7975	15.7000	19.5000
2021.09	29.8942	29.3827	30.4056	39.1000	52.5000
2021.10	28.9615	28.4526	29.4704	27.1000	37.0000
2021.11	29.1470	28.6328	29.6613	27.2000	35.1000
2021.12	30.6152	30.0124	31.2180	50.6000	69.0000
2022.01	73.9873	72.6692	75.3055	43.9000	62.0000
2022.02	65.3821	64.1785	66.5857	48.8000	60.5000
2022.03	70.0726	68.7984	71.3468	58.4000	80.6000
2022.04	72.8618	71.6896	74.0339	59.1000	83.9000
2022.05	80.4969	79.1927	81.8012	72.5000	0.4000
2022.06	66.2116	65.1556	67.2677	58.9000	0.4000
2022.07	72.4897	71.2914	73.6881	76.7000	102.5000
2022.08	73.1951	72.0068	74.3834	63.3000	86.0000
2022.09	82.7178	81.1804	84.2551	72.6000	94.5000
2022.10	78.6409	77.2476	80.0341	66.4000	112.1000
2022.11	79.4895	77.9664	81.0126	54.3000	82.1000
2022.12	81.9245	80.1874	83.6615	93.7000	165.0000
2023.01	121.9936	119.3928	124.5944	112.9000	173.8000
2023.02	105.0216	102.8284	107.2148	89.6000	152.3000

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

ym	Ra	lci99	uci99	aavso	sidc
2023.03	108.9622	106.7254	111.1990	85.0000	126.8000
2023.04	116.8961	114.6617	119.1305	72.1000	114.3000

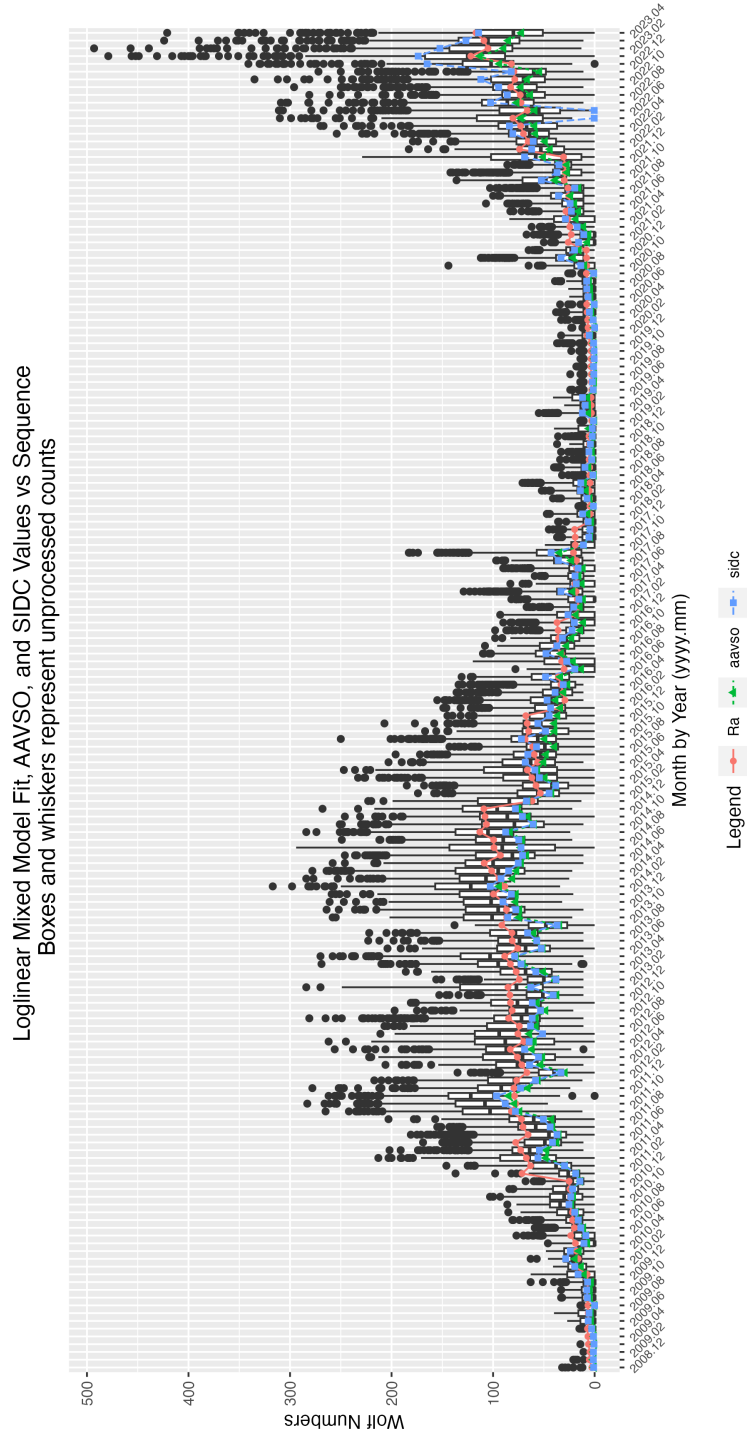


Figure 2: GLMM fitted data for R_a . AAVSO data: <https://www.aavso.org/category/tags/solar-bulletin>. SILSO data: WDC-SILSO, Royal Observatory of Belgium, Brussels

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 contribution to both institutions tend to differ from those observers contributing only to the AAVSO.

5 Supporting Information

Table 3: 202304 Parameter Estimates

	Estimate	Std. Error	t-value	Pr(> t)
(Intercept)	1.2101	0.3164	3.8250	0.0001
seeF	-0.2296	0.0052	-44.1237	0.0000
seeG	-0.1155	0.0046	-25.3853	0.0000
seeM	-0.1908	0.0244	-7.8171	0.0000
seeP	-0.3220	0.0075	-43.2000	0.0000
sidc1	0.0511	0.0124	4.1179	0.0000
year2009	0.7619	0.3178	2.3971	0.0165
year2010	2.0010	0.3156	6.3397	0.0000
year2011	3.1447	0.3155	9.9664	0.0000
year2012	3.1856	0.3155	10.0965	0.0000
year2013	3.2810	0.3155	10.3987	0.0000
year2014	3.4797	0.3155	11.0286	0.0000
year2015	2.9988	0.3155	9.5040	0.0000
year2016	2.3834	0.3156	7.5528	0.0000
year2017	1.7698	0.3156	5.6077	0.0000
year2018	0.4882	0.3159	1.5456	0.1222
year2019	0.0738	0.3161	0.2335	0.8154
year2020	0.8800	0.3158	2.7870	0.0053
year2021	2.1605	0.3156	6.8463	0.0000
year2022	3.1534	0.3155	9.9937	0.0000
year2023	3.6297	0.3156	11.5009	0.0000
mon2	-0.1326	0.0077	-17.1670	0.0000
mon3	-0.0758	0.0073	-10.3748	0.0000
mon4	-0.0158	0.0071	-2.2271	0.0259
mon5	0.0484	0.0073	6.6699	0.0000
mon6	-0.1212	0.0076	-15.9686	0.0000
mon7	-0.0534	0.0073	-7.2760	0.0000
mon8	-0.0420	0.0073	-5.7860	0.0000
mon9	0.0956	0.0073	13.1677	0.0000
mon10	0.0444	0.0074	5.9821	0.0000
mon11	0.0715	0.0077	9.2653	0.0000
mon12	0.0994	0.0077	12.9341	0.0000

Table 4: 202304 Summary of Sunspot Numbers

year	mon	day	obs	sidc
Min. :2008	Min. : 1.000	Min. : 0.0	Length:167512	Min. :0.0000
1st Qu.:2013	1st Qu.: 4.000	1st Qu.: 8.0	Class :character	1st Qu.:0.0000
Median :2017	Median : 7.000	Median :16.0	Mode :character	Median :0.0000
Mean :2017	Mean : 6.551	Mean :15.7		Mean :0.2434
3rd Qu.:2020	3rd Qu.: 9.000	3rd Qu.:23.0		3rd Qu.:0.0000
Max. :2023	Max. :12.000	Max. :31.0		Max. :1.0000

Table 5: 202304 Summary of Sunspot Numbers

g	s	w	see	method
Min. : 0.00	Min. : 0.00	Min. : 0.00	Length:167512	Length:167512
1st Qu.: 1.00	1st Qu.: 1.00	1st Qu.: 11.00	Class :character	Class :character
Median : 2.00	Median : 9.00	Median : 33.00	Mode :character	Mode :character
Mean : 2.92	Mean : 16.86	Mean : 46.06		
3rd Qu.: 5.00	3rd Qu.: 25.00	3rd Qu.: 73.00		
Max. :30.00	Max. :262.00	Max. :493.00		

Table 6: 202304 Summary of Sunspot Numbers

inst	filter	unit
Length:167512	Length:167512	Length:167512
Class :character	Class :character	Class :character
Mode :character	Mode :character	Mode :character

Table 7: 202304 Summary of Sunspot Numbers

aperture	eyep	foclen	mag
Min. : 0.00	Min. : 0.0	Min. : 0.0	Min. : 0.0
1st Qu.: 60.00	1st Qu.: 5.0	1st Qu.: 150.0	1st Qu.: 40.0
Median : 80.00	Median : 14.0	Median : 900.0	Median : 57.0
Mean : 92.75	Mean : 37.9	Mean : 890.4	Mean : 180.6
3rd Qu.: 104.00	3rd Qu.: 23.0	3rd Qu.:1200.0	3rd Qu.: 75.0
Max. :1524.00	Max. :2010.0	Max. :9990.0	Max. :4591.0

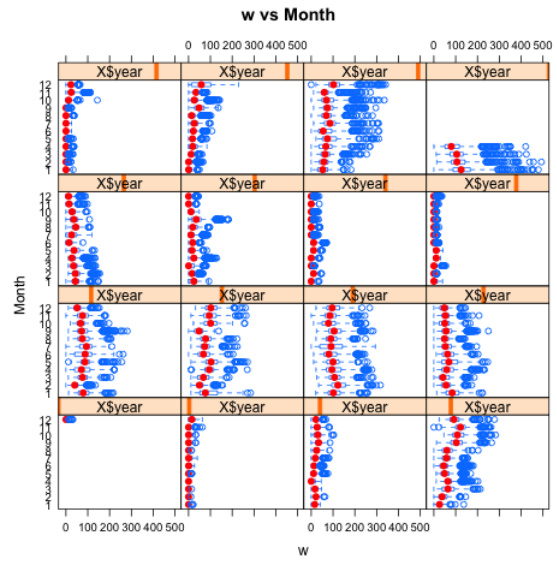
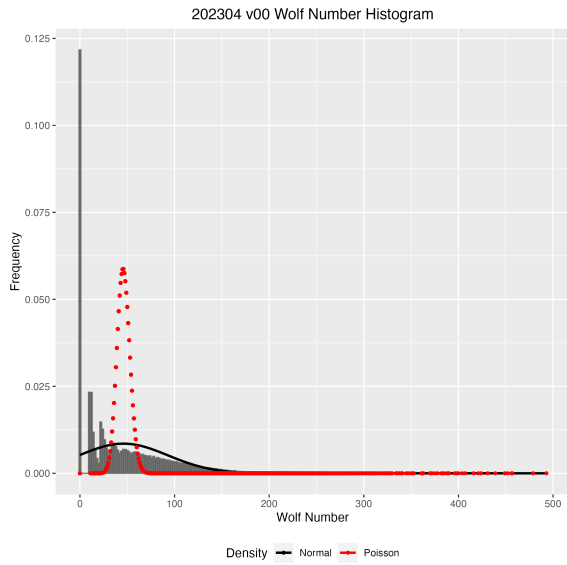


Figure 3: Box plots of raw Wolf number (w) by observer rank.

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

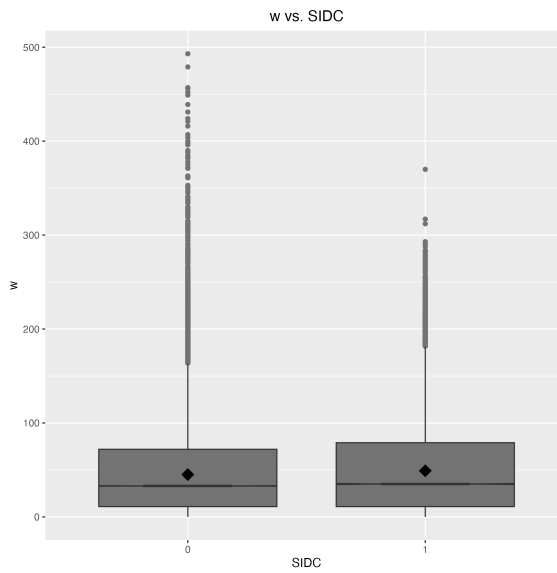
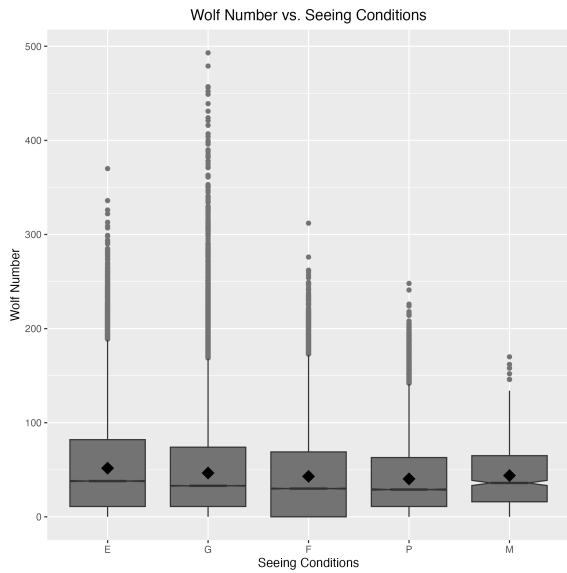


Figure 5: Box plots of raw Wolf number (w) by seeing condition.

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

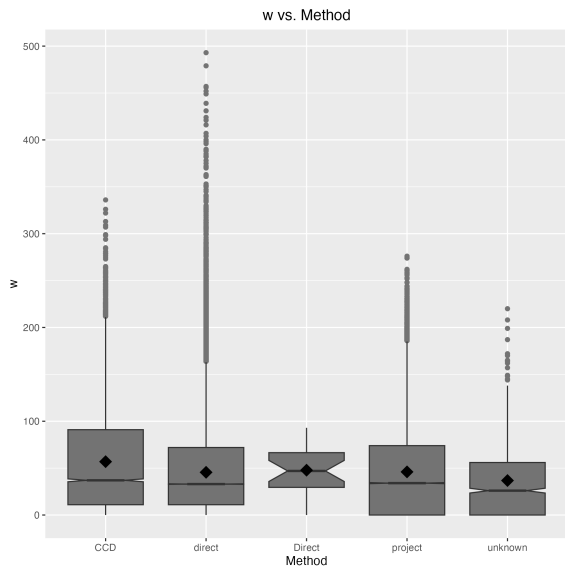


Figure 7: Box plots of raw Wolf number (w) by observer rank.

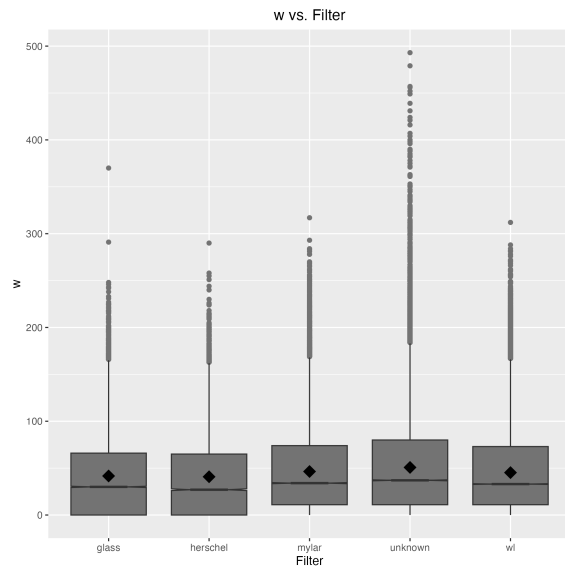


Figure 8: Box plots of raw Wolf number (w) by month and year.

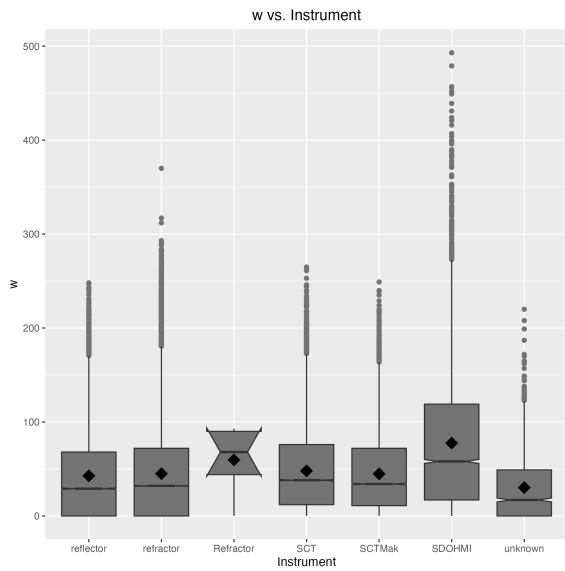


Figure 9: Box plots of raw Wolf number (w) by seeing condition.

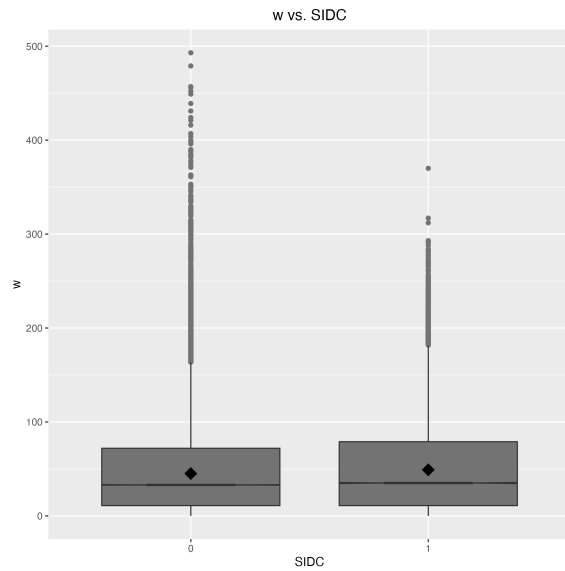


Figure 10: Box plots of raw Wolf number (w) by organization.

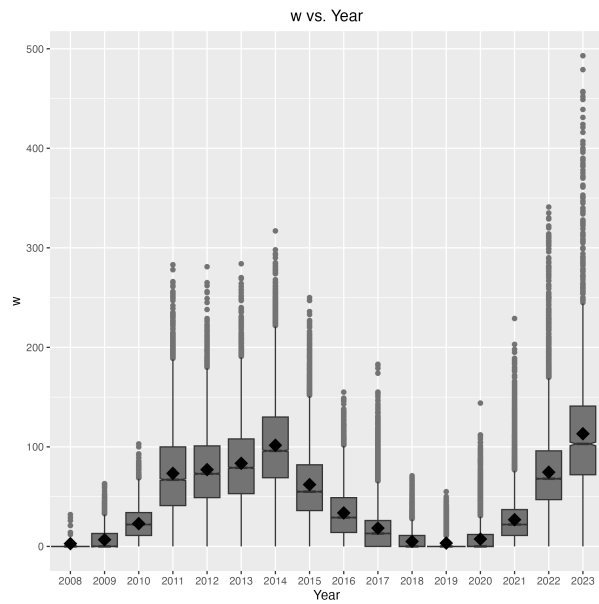


Figure 11: Box plots of raw Wolf number (w) by year.

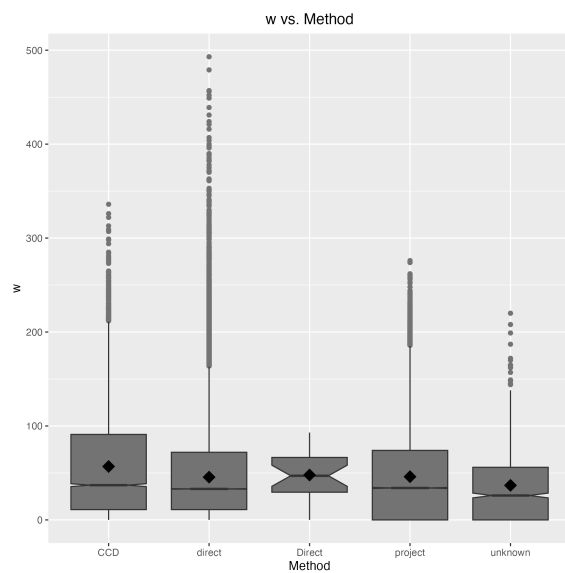


Figure 12: Box plots of raw Wolf number (w) by observing method.