

Monthly Report (00)

2023.02 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.

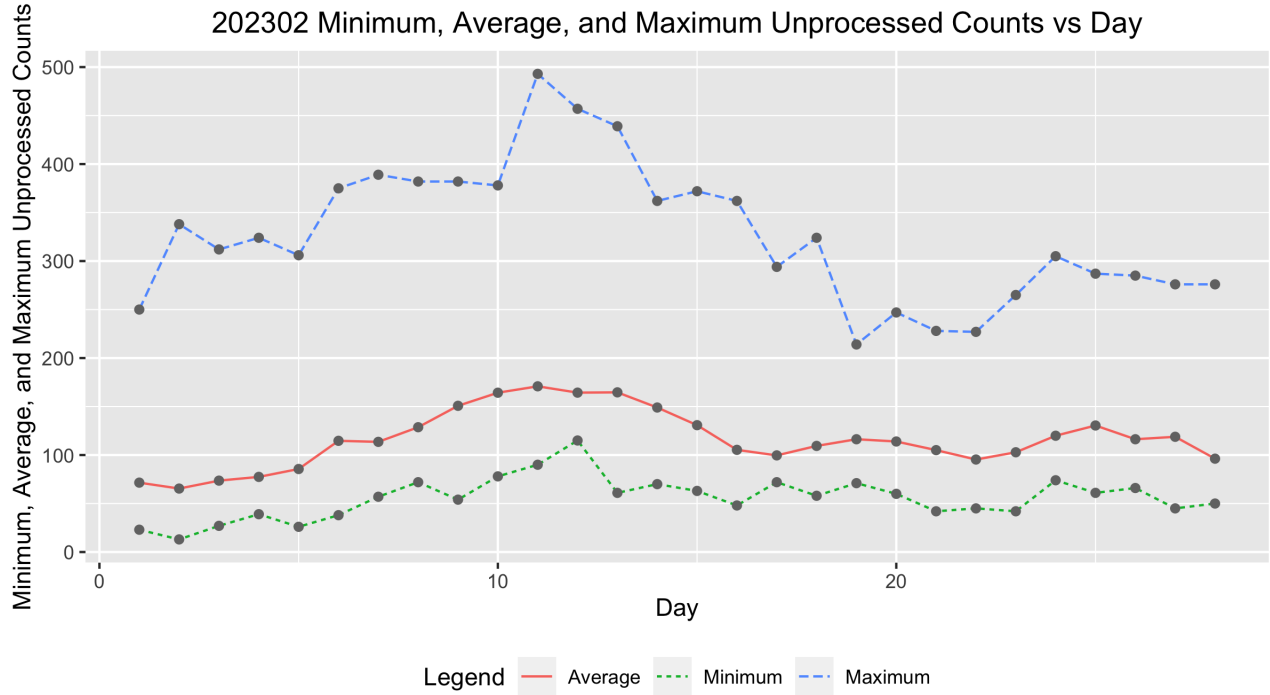


Figure 1: Raw average sunspot count by day of the month.

Table 1: 202302 Daily Raw Counts

Day	Submissions	Minimum	Average	Maximum
1.0000	32.0000	23.0000	71.5312	250.0000
2.0000	28.0000	13.0000	65.4286	338.0000
3.0000	31.0000	27.0000	73.6129	312.0000
4.0000	32.0000	39.0000	77.4688	324.0000
5.0000	32.0000	26.0000	85.5938	306.0000
6.0000	33.0000	38.0000	114.6667	375.0000
7.0000	29.0000	57.0000	113.5862	389.0000
8.0000	35.0000	72.0000	128.6857	382.0000
9.0000	25.0000	54.0000	150.7600	382.0000
10.0000	38.0000	78.0000	164.2632	378.0000
11.0000	42.0000	90.0000	170.8571	493.0000
12.0000	38.0000	115.0000	164.3421	457.0000
13.0000	41.0000	61.0000	164.6341	439.0000
14.0000	41.0000	70.0000	149.0000	362.0000
15.0000	30.0000	63.0000	130.8000	372.0000
16.0000	28.0000	48.0000	105.3571	362.0000
17.0000	33.0000	72.0000	99.6364	294.0000
18.0000	37.0000	58.0000	109.4054	324.0000
19.0000	35.0000	71.0000	116.2857	214.0000
20.0000	28.0000	60.0000	113.9643	247.0000
21.0000	29.0000	42.0000	105.0690	228.0000
22.0000	21.0000	45.0000	95.3810	227.0000
23.0000	20.0000	42.0000	102.8500	265.0000
24.0000	29.0000	74.0000	119.8966	305.0000
25.0000	26.0000	61.0000	130.4615	287.0000
26.0000	28.0000	66.0000	116.2857	285.0000
27.0000	28.0000	45.0000	118.8214	276.0000
28.0000	27.0000	50.0000	96.2593	276.0000

3 Error Tables

Data are for the month of February 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	2.4245	3.1165	0.5000	1.0000
2009.01	5.1289	4.5993	5.6585	1.3000	1.3000
2009.02	4.5794	4.0927	5.0660	0.7000	1.2000
2009.03	6.0872	5.8622	6.3123	0.3000	0.6000
2009.04	6.8735	6.6428	7.1043	0.4000	1.2000
2009.05	7.0629	6.7971	7.3287	1.6000	2.9000
2009.06	6.3572	6.0493	6.6652	3.2000	6.3000
2009.07	6.3371	6.0898	6.5844	3.6000	5.5000
2009.08	6.6321	6.3888	6.8754	0.0000	0.0000
2009.09	7.3321	7.0856	7.5786	4.5000	7.1000
2009.10	6.8598	6.5102	7.2093	4.5000	7.7000
2009.11	6.8681	6.6772	7.0591	3.3000	6.9000
2009.12	7.3276	7.1145	7.5407	10.4000	16.3000
2010.01	19.4513	17.3434	21.5592	13.3000	19.5000
2010.02	15.7348	13.7035	17.7662	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	17.7560	15.6529	19.8591	15.4000	24.0000
2010.04	19.7041	17.4881	21.9202	7.0000	10.4000
2010.05	23.5568	23.1274	23.9863	8.4000	8.7000
2010.06	19.9138	19.5620	20.2656	11.0000	13.6000
2010.07	21.7481	21.4060	22.0901	15.2000	16.1000
2010.08	21.9319	21.5419	22.3219	18.3000	19.6000
2010.09	25.2823	24.8334	25.7311	22.8000	25.2000
2010.10	24.0096	23.5574	24.4619	21.0000	23.5000
2010.11	24.3998	23.9387	24.8609	20.9000	21.6000
2010.12	25.1107	24.5894	25.6320	13.9000	14.5000
2011.01	69.7963	68.3310	71.2616	17.7000	18.7000
2011.02	61.4386	60.0983	62.7790	29.1000	29.6000
2011.03	67.0208	65.6883	68.3532	48.0000	55.8000
2011.04	75.6900	74.2016	77.1784	47.3000	54.4000
2011.05	77.7206	76.3284	79.1129	37.3000	41.5000
2011.06	65.5277	64.3255	66.7298	35.2000	37.0000
2011.07	70.5740	69.3316	71.8164	41.5000	43.8000
2011.08	71.9728	70.7694	73.1761	42.4000	50.5000
2011.09	81.8645	80.3739	83.3552	73.8000	78.0000
2011.10	77.6289	76.2613	78.9965	78.9000	88.0000
2011.11	78.8785	77.2216	80.5354	84.6000	96.7000
2011.12	79.5323	77.8827	81.1819	65.8000	73.0000
2012.01	75.0335	73.5218	76.5452	55.8000	58.2000
2012.02	64.9433	63.5798	66.3068	29.2000	33.1000
2012.03	71.5233	70.2257	72.8209	53.1000	64.1000
2012.04	79.1977	77.7313	80.6641	51.4000	55.2000
2012.05	83.1550	81.7130	84.5971	61.8000	69.0000
2012.06	69.5848	68.3592	70.8105	59.7000	64.5000
2012.07	75.5802	74.2876	76.8728	64.2000	51.3000
2012.08	74.1595	72.9072	75.4119	57.7000	63.1000
2012.09	84.7431	83.2298	86.2564	57.7000	61.5000
2012.10	81.2545	79.7205	82.7884	48.3000	53.3000
2012.11	82.8595	81.1581	84.5609	56.7000	61.4000
2012.12	83.4990	81.6598	85.3381	37.4000	40.8000
2013.01	83.2276	81.5991	84.8561	63.8000	62.9000
2013.02	72.1524	70.6587	73.6461	37.8000	38.0000
2013.03	77.0217	75.4150	78.6285	50.6000	57.9000
2013.04	86.3378	84.7599	87.9157	70.6000	72.4000
2013.05	88.5269	86.8774	90.1764	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	75.5925	74.1912	76.9938	51.0000	52.5000
2013.07	81.1389	79.7662	82.5116	57.0000	57.0000
2013.08	81.3559	79.9852	82.7265	60.0000	66.0000
2013.09	91.3891	89.7032	93.0751	34.6000	36.9000
2013.10	86.5553	84.8987	88.2120	74.5000	85.6000
2013.11	86.8415	84.8220	88.8611	73.9000	77.6000
2013.12	89.9325	87.9788	91.8863	77.8000	90.3000
2014.01	97.2358	95.1473	99.3243	77.4000	82.0000
2014.02	86.1413	84.3759	87.9068	93.9000	102.8000
2014.03	93.9741	92.2076	95.7406	80.9000	92.2000
2014.04	105.4909	103.5678	107.4141	76.9000	84.7000
2014.05	108.7669	106.8487	110.6851	72.3000	75.2000
2014.06	92.7567	91.1185	94.3950	67.2000	71.0000
2014.07	99.1599	97.4291	100.8907	72.5000	72.5000
2014.08	99.4912	97.8771	101.1053	71.2000	74.7000
2014.09	113.0813	111.0092	115.1534	83.2000	87.6000
2014.10	106.5609	104.5460	108.5758	59.5000	60.6000
2014.11	107.9910	105.6767	110.3052	65.8000	71.1000
2014.12	109.1719	106.6249	111.7189	75.8000	78.0000
2015.01	60.0863	58.8696	61.3030	65.9000	67.0000
2015.02	52.0448	50.8538	53.2358	42.4000	44.8000
2015.03	57.5446	56.4611	58.6282	38.0000	38.4000
2015.04	64.2742	63.0767	65.4718	49.0000	54.4000
2015.05	66.3220	65.1884	67.4555	56.3000	58.8000
2015.06	56.2508	55.2312	57.2705	50.2000	68.3000
2015.07	59.5166	58.5057	60.5276	47.9000	65.8000
2015.08	60.9096	59.8891	61.9302	39.5000	57.2000
2015.09	68.5092	67.2631	69.7554	49.2000	72.1000
2015.10	65.0051	63.7492	66.2609	39.3000	48.3000
2015.11	66.4453	64.9885	67.9020	39.6000	55.9000
2015.12	67.7094	66.1959	69.2230	36.4000	44.8000
2016.01	32.8832	32.1948	33.5717	33.7000	43.3000
2016.02	28.4916	27.8948	29.0884	38.3000	46.8000
2016.03	31.0465	30.4232	31.6698	30.5000	38.9000
2016.04	34.4767	33.8157	35.1376	26.6000	30.9000
2016.05	35.7307	35.0761	36.3853	33.7000	48.4000
2016.06	30.0556	29.5405	30.5708	13.1000	19.5000
2016.07	32.4652	31.9424	32.9880	21.2000	27.5000
2016.08	32.8206	32.2413	33.3999	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	37.7739	37.0823	38.4656	27.7000	37.1000
2016.10	35.5434	34.8573	36.2296	22.7000	31.7000
2016.11	35.9362	35.1824	36.6899	14.0000	22.2000
2016.12	37.0862	36.2863	37.8862	11.1000	20.0000
2017.01	17.7160	17.3401	18.0920	18.4000	26.2000
2017.02	15.4106	15.0698	15.7515	14.4000	20.6000
2017.03	16.9207	16.5961	17.2453	11.3000	15.5000
2017.04	18.9762	18.6396	19.3128	21.6000	33.2000
2017.05	19.4044	19.0673	19.7415	12.5000	18.1000
2017.06	16.2740	16.0029	16.5452	15.5000	19.3000
2017.07	17.6538	17.3703	17.9374	11.5000	16.3000
2017.08	17.8089	17.4973	18.1205	22.8000	35.7000
2017.09	20.8271	20.3911	21.2630	34.6000	42.9000
2017.10	19.0750	18.6823	19.4677	10.5000	11.0000
2017.11	19.1713	18.7636	19.5791	4.2000	5.6000
2017.12	19.6801	19.3790	19.9813	4.0000	4.6000
2018.01	4.9530	4.8467	5.0592	3.1000	6.3000
2018.02	4.2673	4.1637	4.3709	6.8000	11.8000
2018.03	4.6121	4.5187	4.7054	1.1000	1.2000
2018.04	5.1159	5.0131	5.2186	4.7000	7.5000
2018.05	5.3040	5.2051	5.4029	8.4000	14.0000
2018.06	4.4698	4.3912	4.5484	10.2000	13.6000
2018.07	4.8552	4.8006	4.9099	0.5000	1.7000
2018.08	4.8436	4.7607	4.9265	5.9000	9.5000
2018.09	5.4571	5.3549	5.5594	1.6000	2.9000
2018.10	5.2641	5.1608	5.3673	2.5000	5.6000
2018.11	5.3052	5.1941	5.4164	3.1000	4.2000
2018.12	5.5482	5.4400	5.6564	1.6000	2.3000
2019.01	3.2791	3.2166	3.3415	5.4000	2.3000
2019.02	2.8837	2.8270	2.9404	0.1000	1.2000
2019.03	3.0837	3.0314	3.1360	6.1000	12.1000
2019.04	3.4558	3.3910	3.5207	6.2000	9.3000
2019.05	3.4740	3.4137	3.5344	7.0000	11.9000
2019.06	2.9395	2.8900	2.9890	0.7000	1.5000
2019.07	3.1870	3.1399	3.2342	0.4000	2.2000
2019.08	3.2313	3.1835	3.2791	0.3000	0.8000
2019.09	3.7182	3.6600	3.7763	0.5000	1.0000
2019.10	3.4801	3.4211	3.5392	0.2000	0.5000
2019.11	3.5864	3.5177	3.6551	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	3.6544	3.5820	3.7268	0.8000	1.0000
2020.01	7.2570	7.1151	7.3989	4.0000	5.3000
2020.02	6.3151	6.1886	6.4416	0.1000	0.0000
2020.03	6.8135	6.6863	6.9407	1.2000	1.5000
2020.04	7.6885	7.5625	7.8144	3.0000	5.1000
2020.05	7.7913	7.6702	7.9124	0.1000	0.4000
2020.06	6.6345	6.5331	6.7359	3.9000	6.4000
2020.07	7.0888	6.9849	7.1928	4.2000	7.7000
2020.08	7.0816	6.9834	7.1798	5.3000	7.8000
2020.09	8.1209	7.9910	8.2508	0.4000	0.9000
2020.10	7.7835	7.6554	7.9115	9.9000	13.6000
2020.11	7.9401	7.8114	8.0687	21.2000	33.1000
2020.12	8.1185	7.9729	8.2640	15.4000	19.8000
2021.01	25.3862	24.9331	25.8392	7.0000	15.8000
2021.02	22.4625	22.0621	22.8629	5.8000	10.7000
2021.03	24.3961	24.0094	24.7828	11.0000	17.2000
2021.04	27.6068	27.1495	28.0641	18.5000	28.8000
2021.05	28.2959	27.8674	28.7245	15.9000	22.9000
2021.06	23.9315	23.5602	24.3028	19.9000	24.1000
2021.07	25.5057	25.0891	25.9224	23.8000	35.6000
2021.08	26.3431	25.9162	26.7699	15.7000	19.5000
2021.09	29.8697	29.3676	30.3718	39.1000	52.5000
2021.10	28.9461	28.4458	29.4464	27.1000	37.0000
2021.11	29.1773	28.6738	29.6808	27.2000	35.1000
2021.12	30.6383	30.0487	31.2278	50.6000	69.0000
2022.01	72.1741	70.9192	73.4291	43.9000	62.0000
2022.02	63.6808	62.5371	64.8244	48.8000	60.5000
2022.03	69.8995	68.6590	71.1400	58.4000	80.6000
2022.04	75.8785	74.6838	77.0732	59.1000	83.9000
2022.05	80.5478	79.2689	81.8268	72.5000	0.4000
2022.06	66.2799	65.2396	67.3201	58.9000	0.4000
2022.07	72.5741	71.3993	73.7488	76.7000	102.5000
2022.08	73.2372	72.0703	74.4041	63.3000	86.0000
2022.09	82.7788	81.2731	84.2845	72.6000	94.5000
2022.10	78.6231	77.2577	79.9885	66.4000	112.1000
2022.11	79.4573	77.9691	80.9455	54.3000	82.1000
2022.12	81.8690	80.1871	83.5509	93.7000	165.0000
2023.01	136.7070	133.8564	139.5576	112.9000	173.8000

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

ym	Ra	lci99	uci99	aavso	sidc
2023.02	117.8781	115.5026	120.2537	89.6000	152.3000

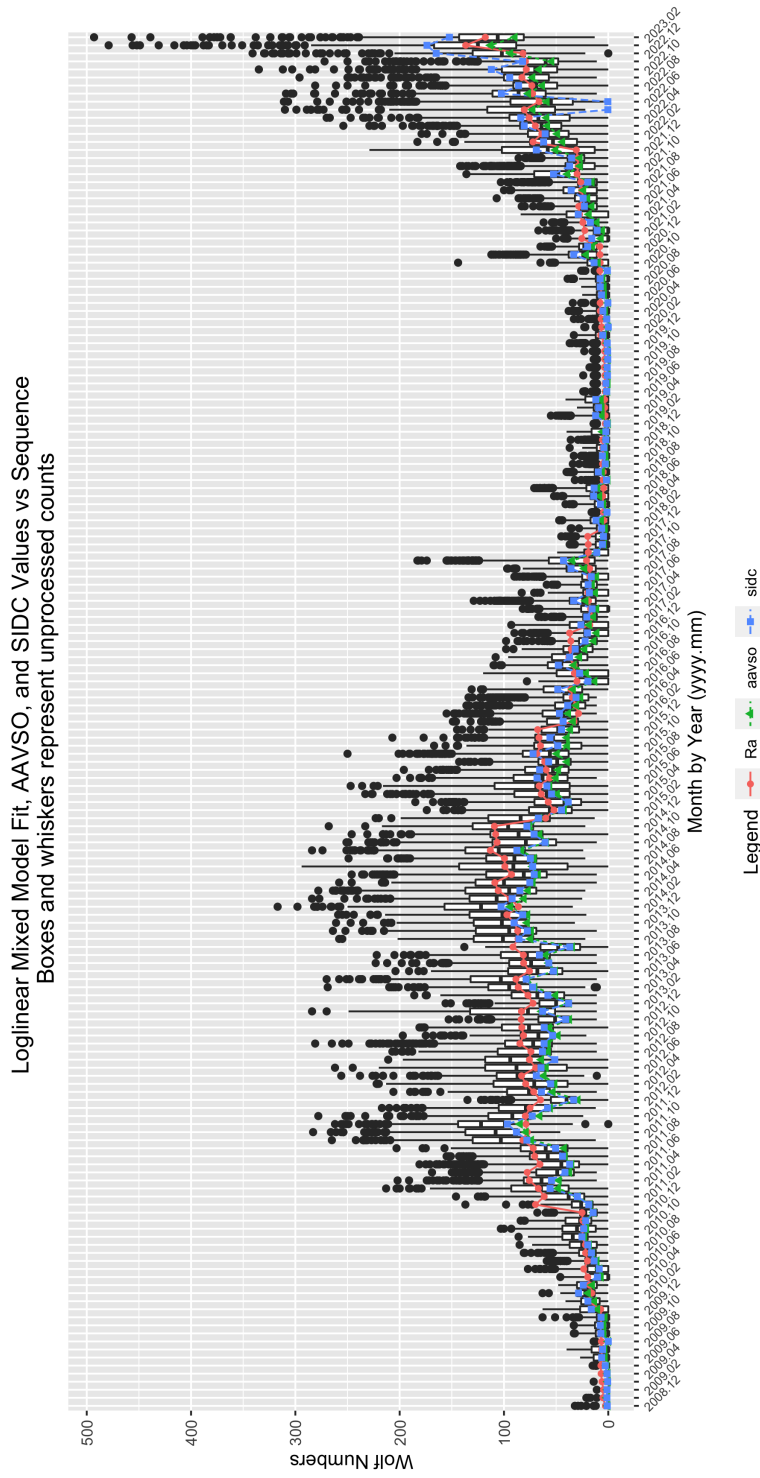


Figure 2: GLMM fitted data for R_a . AAVSO data: <https://www.aavso.org/category/tags/solar-bulletin>. SILSO data: WDC-SILSO, Royal Observatory of Belgium, Brussels

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

5 Supporting Information

Table 3: 202302 Parameter Estimates

	Estimate	Std. Error	t-value	Pr(> t)
(Intercept)	1.1903	0.3156	3.7719	0.0002
seeF	-0.2286	0.0053	-43.5335	0.0000
seeG	-0.1177	0.0046	-25.6400	0.0000
seeM	-0.1874	0.0244	-7.6947	0.0000
seeP	-0.3228	0.0075	-42.8663	0.0000
sidc1	0.0529	0.0127	4.1539	0.0000
year2009	0.7638	0.3170	2.4092	0.0160
year2010	2.0021	0.3148	6.3592	0.0000
year2011	3.1455	0.3147	9.9941	0.0000
year2012	3.1870	0.3147	10.1262	0.0000
year2013	3.2819	0.3147	10.4279	0.0000
year2014	3.4807	0.3147	11.0598	0.0000
year2015	2.9987	0.3147	9.5278	0.0000
year2016	2.3834	0.3148	7.5719	0.0000
year2017	1.7694	0.3148	5.6205	0.0000
year2018	0.4879	0.3151	1.5485	0.1215
year2019	0.0730	0.3153	0.2314	0.8170
year2020	0.8788	0.3150	2.7902	0.0053
year2021	2.1599	0.3148	6.8618	0.0000
year2022	3.1508	0.3147	10.0105	0.0000
year2023	3.7677	0.3149	11.9655	0.0000
mon2	-0.1344	0.0077	-17.4263	0.0000
mon3	-0.0532	0.0078	-6.7817	0.0000
mon4	0.0497	0.0075	6.5891	0.0000
mon5	0.0739	0.0074	10.0137	0.0000
mon6	-0.0959	0.0077	-12.4422	0.0000
mon7	-0.0281	0.0075	-3.7617	0.0002
mon8	-0.0167	0.0074	-2.2585	0.0239
mon9	0.1209	0.0074	16.3710	0.0000
mon10	0.0697	0.0075	9.2404	0.0000
mon11	0.0965	0.0078	12.3246	0.0000
mon12	0.1242	0.0078	15.9204	0.0000

Table 4: 202302 Summary of Sunspot Numbers

year	mon	day	obs	sidc
Min. :2008	Min. : 1.000	Min. : 0.0	Length:165546	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 :2016	Mean : 6.587	Mean :15.7		Mean :0.2442
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: 202302 Summary of Sunspot Numbers

g	s	w	see	method
Min. : 0.000	Min. : 0.00	Min. : 0.00	Length:165546	Length:165546
1st Qu.: 1.000	1st Qu.: 1.00	1st Qu.: 11.00	Class :character	Class :character
Median : 2.000	Median : 9.00	Median : 33.00	Mode :character	Mode :character
Mean : 2.874	Mean : 16.67	Mean : 45.41		
3rd Qu.: 5.000	3rd Qu.: 25.00	3rd Qu.: 72.00		
Max. :30.000	Max. :262.00	Max. :493.00		

Table 6: 202302 Summary of Sunspot Numbers

inst	filter	unit
Length:165546	Length:165546	Length:165546
Class :character	Class :character	Class :character
Mode :character	Mode :character	Mode :character

Table 7: 202302 Summary of Sunspot Numbers

aperture	eyep	foclen	mag
Min. : 0.00	Min. : 0.00	Min. : 0.0	Min. : 0.0
1st Qu.: 60.00	1st Qu.: 5.00	1st Qu.: 150.0	1st Qu.: 40.0
Median : 80.00	Median : 14.00	Median : 900.0	Median : 57.0
Mean : 92.63	Mean : 37.47	Mean : 890.6	Mean : 180.6
3rd Qu.: 104.00	3rd Qu.: 23.00	3rd Qu.:1200.0	3rd Qu.: 75.0
Max. :1524.00	Max. :2010.00	Max. :9990.0	Max. :4591.0

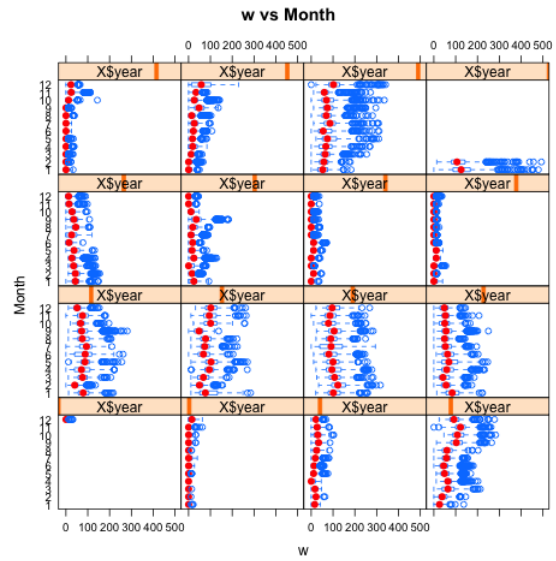
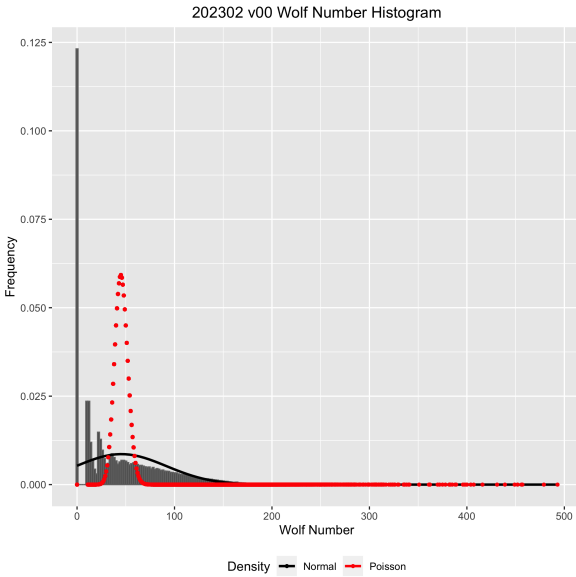


Figure 3: Box plots of raw Wolf number (w) by observer rank.

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

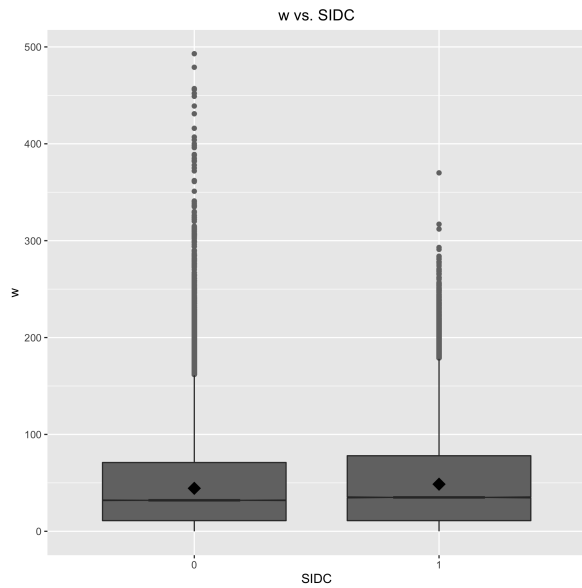
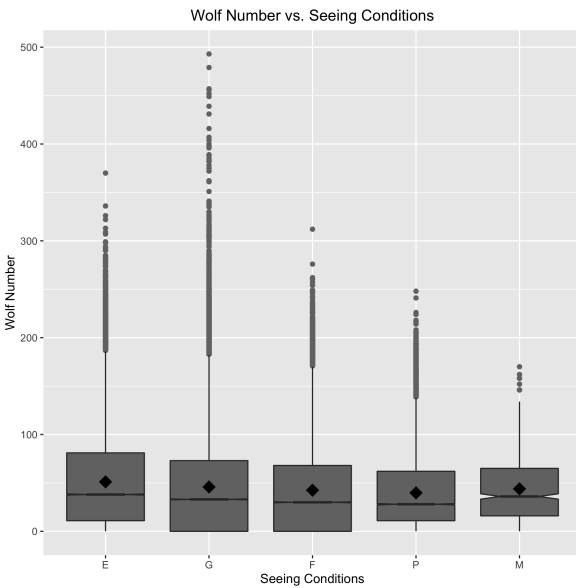


Figure 5: Box plots of raw Wolf number (w) by seeing condition.

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

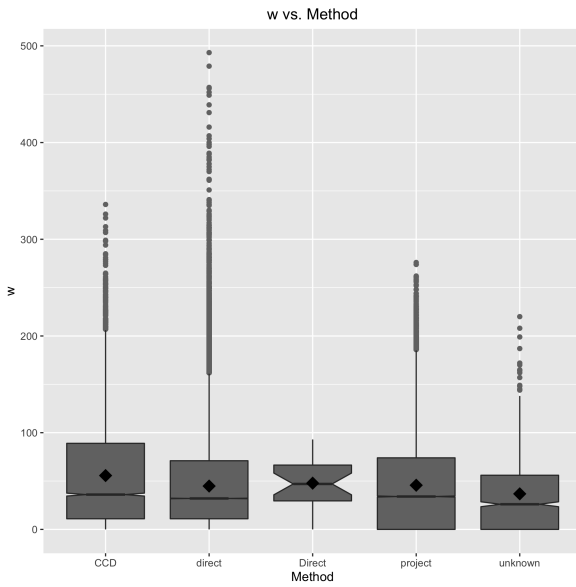


Figure 7: Box plots of raw Wolf number (w) by observer rank.

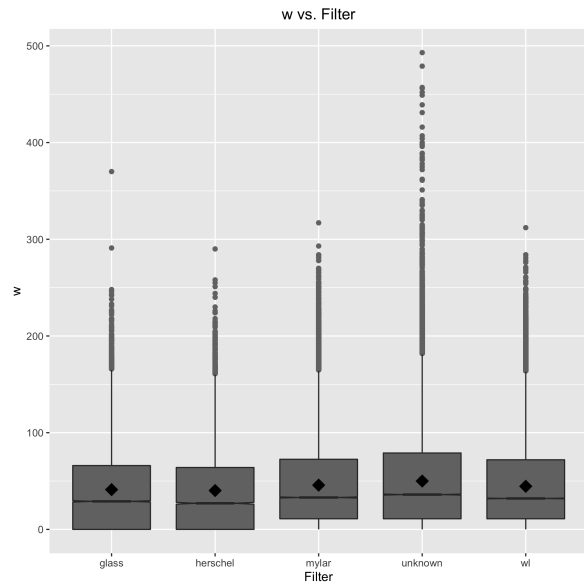


Figure 8: Box plots of raw Wolf number (w) by month and year.

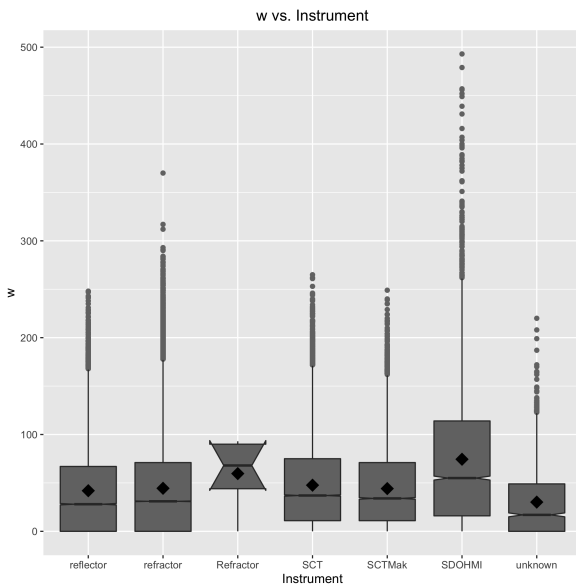


Figure 9: Box plots of raw Wolf number (w) by seeing condition.

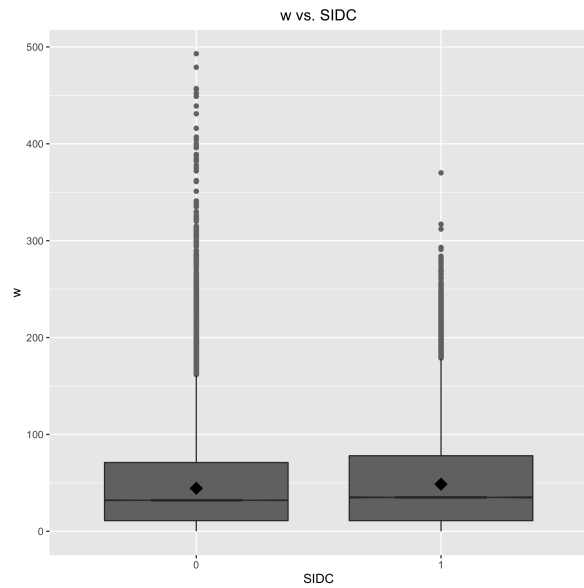


Figure 10: Box plots of raw Wolf number (w) by organization.

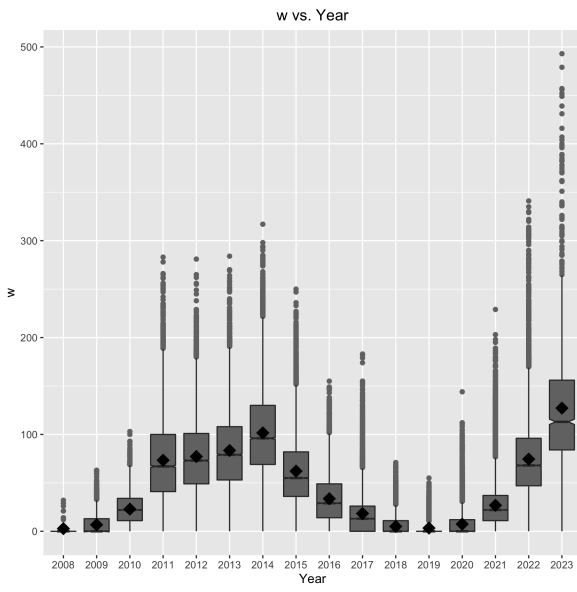


Figure 11: Box plots of raw Wolf number (w) by year.

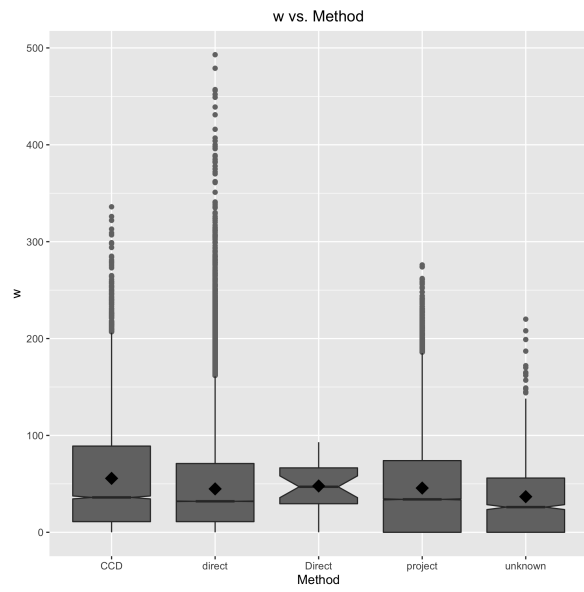


Figure 12: Box plots of raw Wolf number (w) by observing method.