Monthly Report (00)

2023.05 Data Set

Wednesday 14th June, 2023

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.

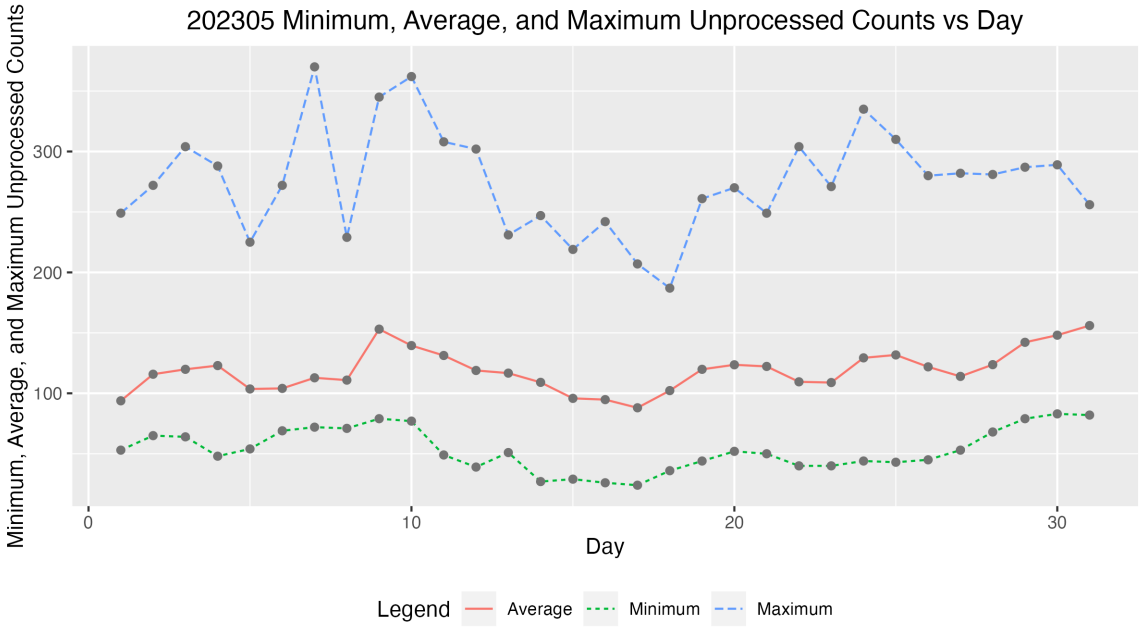

Figure 1: Raw average sunspot count by day of the month.

Table 1: 202305 Daily Raw Counts

Day	Submissions	Minimum	Average	Maximum
1.0000	35.0000	53.0000	93.8000	249.0000
2.0000	37.0000	65.0000	115.7838	272.0000
3.0000	38.0000	64.0000	119.8421	304.0000
4.0000	32.0000	48.0000	122.9375	288.0000
5.0000	37.0000	54.0000	103.5946	225.0000
6.0000	34.0000	69.0000	104.0588	272.0000
7.0000	35.0000	72.0000	112.8286	370.0000
8.0000	34.0000	71.0000	110.9118	229.0000
9.0000	30.0000	79.0000	153.0667	345.0000
10.0000	34.0000	77.0000	139.5000	362.0000
11.0000	35.0000	49.0000	131.2857	308.0000
12.0000	38.0000	39.0000	118.8947	302.0000
13.0000	33.0000	51.0000	116.6970	231.0000
14.0000	35.0000	27.0000	109.0571	247.0000
15.0000	39.0000	29.0000	95.8205	219.0000
16.0000	36.0000	26.0000	94.7778	242.0000
17.0000	37.0000	24.0000	88.0270	207.0000
18.0000	39.0000	36.0000	102.2308	187.0000
19.0000	31.0000	44.0000	119.8387	261.0000
20.0000	34.0000	52.0000	123.5882	270.0000
21.0000	43.0000	50.0000	122.2326	249.0000
22.0000	34.0000	40.0000	109.5000	304.0000
23.0000	41.0000	40.0000	108.9024	271.0000
24.0000	44.0000	44.0000	129.3182	335.0000
25.0000	43.0000	43.0000	131.7442	310.0000
26.0000	50.0000	45.0000	121.8800	280.0000
27.0000	45.0000	53.0000	113.9778	282.0000
28.0000	41.0000	68.0000	123.7073	281.0000
29.0000	45.0000	79.0000	142.1778	287.0000
30.0000	40.0000	83.0000	148.0750	289.0000
31.0000	40.0000	82.0000	156.0250	256.0000

3 Error Tables

Data are for the month of May 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 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 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	2.4231	3.1179	0.5000	1.0000
2009.01	5.2586	4.7131	5.8040	1.3000	1.3000
2009.02	4.7064	4.2038	5.2089	0.7000	1.2000
2009.03	6.1081	5.8832	6.3331	0.3000	0.6000
2009.04	6.6099	6.3889	6.8308	0.4000	1.2000
2009.05	7.0170	6.7531	7.2809	1.6000	2.9000
2009.06	6.3559	6.0500	6.6617	3.2000	6.3000
2009.07	6.3346	6.0877	6.5815	3.6000	5.5000
2009.08	6.6362	6.3932	6.8791	0.0000	0.0000
2009.09	7.3275	7.0820	7.5729	4.5000	7.1000
2009.10	6.8526	6.5036	7.2016	4.5000	7.7000
2009.11	6.8649	6.6711	7.0586	3.3000	6.9000
2009.12	7.3257	7.1085	7.5428	10.4000	16.3000
2010.01	19.9832	17.8102	22.1562	13.3000	19.5000
2010.02	16.1844	14.0867	18.2821	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	17.8439	15.7204	19.9673	15.4000	24.0000
2010.04	18.9615	16.8191	21.1040	7.0000	10.4000
2010.05	23.4117	22.9770	23.8464	8.4000	8.7000
2010.06	19.9282	19.5687	20.2878	11.0000	13.6000
2010.07	21.7696	21.4177	22.1214	15.2000	16.1000
2010.08	21.9597	21.5588	22.3606	18.3000	19.6000
2010.09	25.3048	24.8420	25.7676	22.8000	25.2000
2010.10	24.0452	23.5778	24.5126	21.0000	23.5000
2010.11	24.4089	23.9384	24.8794	20.9000	21.6000
2010.12	25.1251	24.5903	25.6599	13.9000	14.5000
2011.01	71.6660	70.1264	73.2057	17.7000	18.7000
2011.02	63.1996	61.7851	64.6142	29.1000	29.6000
2011.03	67.3332	65.9666	68.6998	48.0000	55.8000
2011.04	72.9639	71.4889	74.4390	47.3000	54.4000
2011.05	77.3237	75.9024	78.7449	37.3000	41.5000
2011.06	65.5581	64.3291	66.7871	35.2000	37.0000
2011.07	70.5937	69.3303	71.8571	41.5000	43.8000
2011.08	72.0112	70.7834	73.2391	42.4000	50.5000
2011.09	81.9261	80.4009	83.4513	73.8000	78.0000
2011.10	77.6731	76.2753	79.0708	78.9000	88.0000
2011.11	78.8661	77.1896	80.5426	84.6000	96.7000
2011.12	79.5340	77.8656	81.2023	65.8000	73.0000
2012.01	77.0621	75.4896	78.6347	55.8000	58.2000
2012.02	66.8459	65.4224	68.2693	29.2000	33.1000
2012.03	71.8228	70.5033	73.1423	53.1000	64.1000
2012.04	76.1974	74.7618	77.6331	51.4000	55.2000
2012.05	82.6652	81.2052	84.1252	61.8000	69.0000
2012.06	69.5994	68.3510	70.8477	59.7000	64.5000
2012.07	75.5876	74.2704	76.9047	64.2000	51.3000
2012.08	74.1627	72.8868	75.4385	57.7000	63.1000
2012.09	84.7244	83.1919	86.2569	57.7000	61.5000
2012.10	81.2308	79.6763	82.7852	48.3000	53.3000
2012.11	82.8428	81.1248	84.5607	56.7000	61.4000
2012.12	83.4434	81.5916	85.2953	37.4000	40.8000
2013.01	85.4965	83.8068	87.1862	63.8000	62.9000
2013.02	74.2668	72.7105	75.8232	37.8000	38.0000
2013.03	77.3577	75.7286	78.9868	50.6000	57.9000
2013.04	83.0936	81.5552	84.6320	70.6000	72.4000
2013.05	88.0293	86.3630	89.6956	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	75.6226	74.1960	77.0493	51.0000	52.5000
2013.07	81.1907	79.7921	82.5892	57.0000	57.0000
2013.08	81.3894	79.9959	82.7829	60.0000	66.0000
2013.09	91.4088	89.7015	93.1161	34.6000	36.9000
2013.10	86.5548	84.8784	88.2313	74.5000	85.6000
2013.11	86.8649	84.8204	88.9094	73.9000	77.6000
2013.12	89.9315	87.9651	91.8980	77.8000	90.3000
2014.01	99.8746	97.7131	102.0362	77.4000	82.0000
2014.02	88.6788	86.8363	90.5212	93.9000	102.8000
2014.03	94.3902	92.5957	96.1846	80.9000	92.2000
2014.04	101.5388	99.6617	103.4159	76.9000	84.7000
2014.05	108.1542	106.2236	110.0848	72.3000	75.2000
2014.06	92.7942	91.1287	94.4598	67.2000	71.0000
2014.07	99.2041	97.4443	100.9640	72.5000	72.5000
2014.08	99.5064	97.8674	101.1454	71.2000	74.7000
2014.09	113.0745	110.9716	115.1773	83.2000	87.6000
2014.10	106.5174	104.4815	108.5533	59.5000	60.6000
2014.11	107.9776	105.6383	110.3169	65.8000	71.1000
2014.12	109.0703	106.5168	111.6237	75.8000	78.0000
2015.01	61.7355	60.4782	62.9928	65.9000	67.0000
2015.02	53.6175	52.3754	54.8595	42.4000	44.8000
2015.03	57.8501	56.7488	58.9515	38.0000	38.4000
2015.04	61.9085	60.7379	63.0792	49.0000	54.4000
2015.05	65.9637	64.8228	67.1047	56.3000	58.8000
2015.06	56.2396	55.2144	57.2648	50.2000	68.3000
2015.07	59.5047	58.4921	60.5174	47.9000	65.8000
2015.08	60.8852	59.8628	61.9076	39.5000	57.2000
2015.09	68.4882	67.2399	69.7365	49.2000	72.1000
2015.10	64.9786	63.7213	66.2360	39.3000	48.3000
2015.11	66.4351	64.9744	67.8958	39.6000	55.9000
2015.12	67.7357	66.2164	69.2550	36.4000	44.8000
2016.01	33.7891	33.0795	34.4987	33.7000	43.3000
2016.02	29.3337	28.7176	29.9498	38.3000	46.8000
2016.03	31.1911	30.5630	31.8192	30.5000	38.9000
2016.04	33.1823	32.5445	33.8201	26.6000	30.9000
2016.05	35.5067	34.8549	36.1585	33.7000	48.4000
2016.06	30.0456	29.5289	30.5622	13.1000	19.5000
2016.07	32.4626	31.9380	32.9872	21.2000	27.5000
2016.08	32.8124	32.2313	33.3936	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	37.7618	37.0679	38.4557	27.7000	37.1000
2016.10	35.5209	34.8329	36.2088	22.7000	31.7000
2016.11	35.9169	35.1618	36.6721	14.0000	22.2000
2016.12	37.0826	36.2807	37.8845	11.1000	20.0000
2017.01	18.2074	17.8199	18.5949	18.4000	26.2000
2017.02	15.8670	15.5150	16.2190	14.4000	20.6000
2017.03	16.9975	16.6704	17.3245	11.3000	15.5000
2017.04	18.2590	17.9340	18.5840	21.6000	33.2000
2017.05	19.2851	18.9490	19.6212	12.5000	18.1000
2017.06	16.2747	16.0028	16.5466	15.5000	19.3000
2017.07	17.6618	17.3774	17.9461	11.5000	16.3000
2017.08	17.8139	17.5014	18.1263	22.8000	35.7000
2017.09	20.8248	20.3877	21.2620	34.6000	42.9000
2017.10	19.0625	18.6693	19.4556	10.5000	11.0000
2017.11	19.1708	18.7623	19.5792	4.2000	5.6000
2017.12	19.6884	19.3865	19.9902	4.0000	4.6000
2018.01	5.0873	4.9779	5.1967	3.1000	6.3000
2018.02	4.3924	4.2858	4.4991	6.8000	11.8000
2018.03	4.6327	4.5389	4.7265	1.1000	1.2000
2018.04	4.9203	4.8214	5.0192	4.7000	7.5000
2018.05	5.2708	5.1725	5.3690	8.4000	14.0000
2018.06	4.4683	4.3896	4.5469	10.2000	13.6000
2018.07	4.8563	4.8017	4.9110	0.5000	1.7000
2018.08	4.8440	4.7610	4.9270	5.9000	9.5000
2018.09	5.4570	5.3548	5.5593	1.6000	2.9000
2018.10	5.2627	5.1596	5.3658	2.5000	5.6000
2018.11	5.3038	5.1928	5.4149	3.1000	4.2000
2018.12	5.5464	5.4381	5.6547	1.6000	2.3000
2019.01	3.3697	3.3055	3.4340	5.4000	2.3000
2019.02	2.9683	2.9098	3.0267	0.1000	1.2000
2019.03	3.0978	3.0452	3.1504	6.1000	12.1000
2019.04	3.3258	3.2632	3.3883	6.2000	9.3000
2019.05	3.4529	3.3928	3.5130	7.0000	11.9000
2019.06	2.9393	2.8898	2.9889	0.7000	1.5000
2019.07	3.1873	3.1400	3.2346	0.4000	2.2000
2019.08	3.2309	3.1831	3.2788	0.3000	0.8000
2019.09	3.7165	3.6582	3.7747	0.5000	1.0000
2019.10	3.4784	3.4194	3.5374	0.2000	0.5000
2019.11	3.5868	3.5180	3.6556	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	3.5818	3.7271	0.8000	1.0000
2020.01	7.4590	7.3128	7.6051	4.0000	5.3000
2020.02	6.5022	6.3717	6.6326	0.1000	0.0000
2020.03	6.8477	6.7197	6.9756	1.2000	1.5000
2020.04	7.4020	7.2807	7.5233	3.0000	5.1000
2020.05	7.7456	7.6253	7.8660	0.1000	0.4000
2020.06	6.6355	6.5338	6.7372	3.9000	6.4000
2020.07	7.0913	6.9869	7.1957	4.2000	7.7000
2020.08	7.0829	6.9845	7.1813	5.3000	7.8000
2020.09	8.1188	7.9884	8.2491	0.4000	0.9000
2020.10	7.7813	7.6531	7.9095	9.9000	13.6000
2020.11	7.9373	7.8082	8.0665	21.2000	33.1000
2020.12	8.1200	7.9739	8.2661	15.4000	19.8000
2021.01	26.0560	25.5907	26.5214	7.0000	15.8000
2021.02	23.1130	22.7012	23.5248	5.8000	10.7000
2021.03	24.5011	24.1128	24.8893	11.0000	17.2000
2021.04	26.6046	26.1519	27.0573	18.5000	28.8000
2021.05	28.1588	27.7214	28.5961	15.9000	22.9000
2021.06	23.9684	23.5881	24.3488	19.9000	24.1000
2021.07	25.5347	25.1128	25.9567	23.8000	35.6000
2021.08	26.3469	25.9156	26.7781	15.7000	19.5000
2021.09	29.8655	29.3592	30.3717	39.1000	52.5000
2021.10	28.9444	28.4378	29.4510	27.1000	37.0000
2021.11	29.1486	28.6315	29.6656	27.2000	35.1000
2021.12	30.6193	30.0136	31.2251	50.6000	69.0000
2022.01	74.1615	72.8341	75.4889	43.9000	62.0000
2022.02	65.5442	64.3316	66.7567	48.8000	60.5000
2022.03	70.2410	68.9578	71.5243	58.4000	80.6000
2022.04	73.0184	71.8389	74.1979	59.1000	83.9000
2022.05	79.9453	78.6635	81.2271	72.5000	0.4000
2022.06	66.1590	65.1145	67.2035	58.9000	0.4000
2022.07	72.4103	71.2250	73.5955	76.7000	102.5000
2022.08	73.1564	71.9828	74.3300	63.3000	86.0000
2022.09	82.7546	81.2193	84.2899	72.6000	94.5000
2022.10	78.6851	77.2902	80.0799	66.4000	112.1000
2022.11	79.5274	77.9969	81.0578	54.3000	82.1000
2022.12	81.9909	80.2393	83.7424	93.7000	165.0000
2023.01	120.7473	118.1616	123.3331	112.9000	173.8000
2023.02	103.9552	101.7728	106.1377	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	107.8315	105.6062	110.0567	85.0000	126.8000
2023.04	115.7626	113.5570	117.9682	72.1000	114.3000
2023.05	122.7136	120.3101	125.1171	105.0000	140.0000

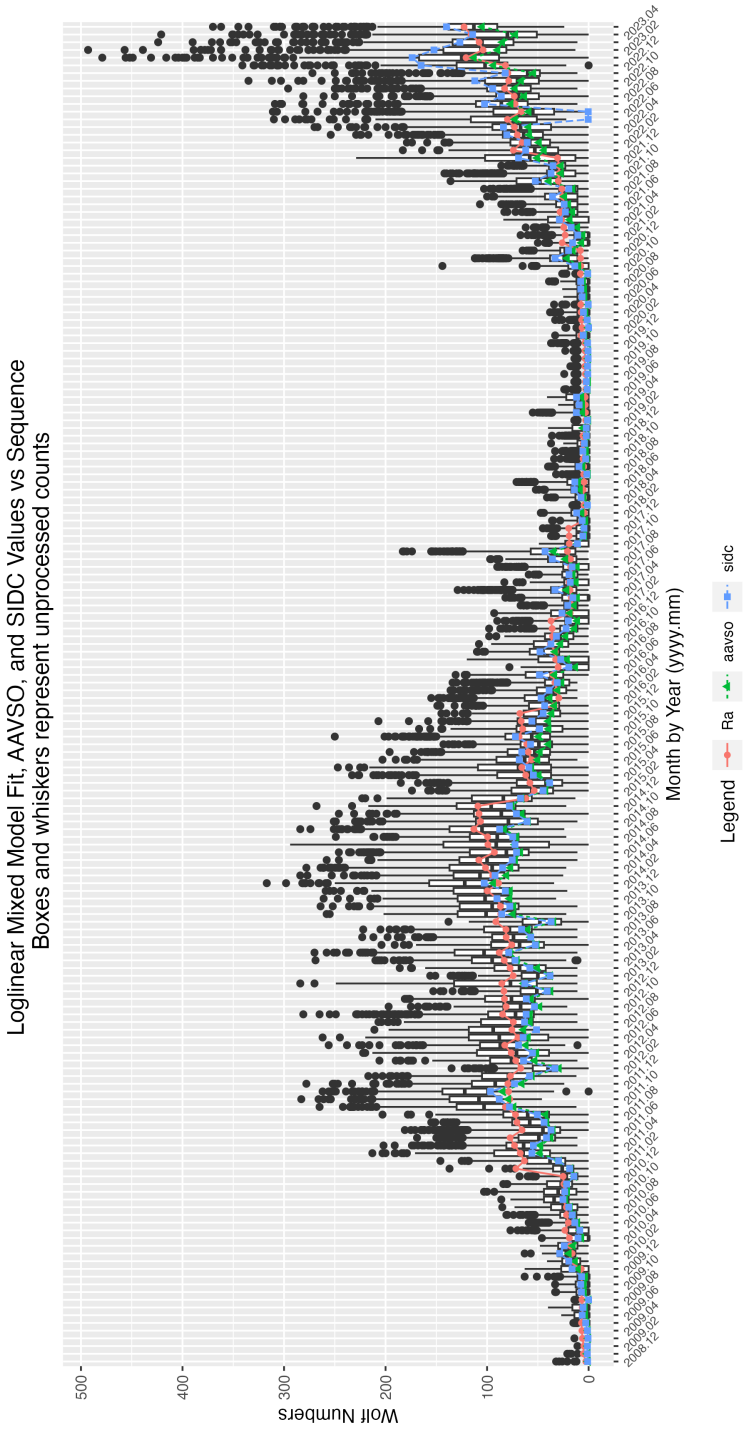

Figure 2: GLMM fitted data for R_a. AAVSO data: https://www.aavso.org/category/tags/solar-bulletin. SILSO data: WDC-SILSO, Royal Observatory of Belgium, Brussels

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

5 Supporting Information

Table 3: 202305 Parameter Estimates

	Estimate	Std. Error	t-value	Pr(>|t|)
(Intercept)	1.2051	0.3157	3.8176	0.0001
seeF	-0.2291	0.0051	-44.5486	0.0000
seeG	-0.1146	0.0045	-25.4996	0.0000
seeM	-0.1897	0.0243	-7.7904	0.0000
seeP	-0.3206	0.0074	-43.4009	0.0000
sidc1	0.0495	0.0122	4.0632	0.0000
year2009	0.7614	0.3172	2.4006	0.0164
year2010	2.0014	0.3150	6.3545	0.0000
year2011	3.1446	0.3149	9.9875	0.0000
year2012	3.1857	0.3148	10.1182	0.0000
year2013	3.2810	0.3148	10.4210	0.0000
year2014	3.4798	0.3148	11.0524	0.0000
year2015	2.9992	0.3149	9.5255	0.0000
year2016	2.3838	0.3149	7.5702	0.0000
year2017	1.7702	0.3149	5.6211	0.0000
year2018	0.4886	0.3152	1.5500	0.1211
year2019	0.0743	0.3154	0.2354	0.8139
year2020	0.8805	0.3151	2.7944	0.0052
year2021	2.1610	0.3149	6.8625	0.0000
year2022	3.1543	0.3149	10.0178	0.0000
year2023	3.6172	0.3149	11.4866	0.0000
mon2	-0.1326	0.0077	-17.1972	0.0000
mon3	-0.0759	0.0073	-10.4069	0.0000
mon4	-0.0162	0.0071	-2.2850	0.0223
mon5	0.0405	0.0069	5.8776	0.0000
mon6	-0.1231	0.0075	-16.3121	0.0000
mon7	-0.0553	0.0073	-7.5734	0.0000
mon8	-0.0440	0.0072	-6.0860	0.0000
mon9	0.0936	0.0072	12.9594	0.0000
mon10	0.0423	0.0074	5.7295	0.0000
mon11	0.0694	0.0077	9.0366	0.0000
mon12	0.0973	0.0076	12.7281	0.0000

Table 4: 202305 Summary of Sunspot Numbers

year	mon	day	obs	sidc
Min. :2008	Min. : 1.00	Min. : 0.00	Length:168681	Min. :0.000
1st Qu.:2013	1st Qu.: 4.00	1st Qu.: 8.00	Class :character	1st Qu.:0.000
Median :2017	Median : 7.00	Median :16.00	Mode :character	Median :0.000
Mean :2017	Mean : 6.54	Mean :15.71		Mean :0.243
3rd Qu.:2020	3rd Qu.: 9.00	3rd Qu.:23.00		3rd Qu.:0.000
Max. :2023	Max. :12.00	Max. :31.00		Max. :1.000

Table 5: 202305 Summary of Sunspot Numbers

g	s	w	see	method
Min. : 0.000	Min. : 0.00	Min. : 0.00	Length:168681	Length:168681
1st Qu.: 1.000	1st Qu.: 1.00	1st Qu.: 11.00	Class :character	Class :character
Median : 2.000	Median : 9.00	Median : 34.00	Mode :character	Mode :character
Mean : 2.949	Mean : 17.07	Mean : 46.57		
3rd Qu.: 5.000	3rd Qu.: 25.00	3rd Qu.: 74.00		
Max. :30.000	Max. :262.00	Max. :493.00		

Table 6: 202305 Summary of Sunspot Numbers

inst	filter	unit
Length:168681	Length:168681	Length:168681
Class :character	Class :character	Class :character
Mode :character	Mode :character	Mode :character

Table 7: 202305 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 : 92.84	Mean : 38.07	Mean : 890.3	Mean : 180.6
3rd Qu.: 104.00	3rd Qu.: 23.00	3rd Qu.:1200.0	3rd Qu.: 73.0
Max. :1524.00	Max. :2010.00	Max. :9990.0	Max. :4591.0

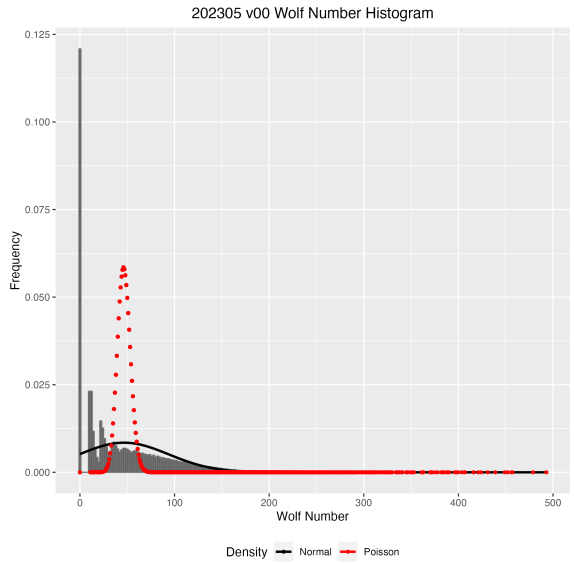

Figure 3: Box plots of raw Wolf number (w) by observer rank.

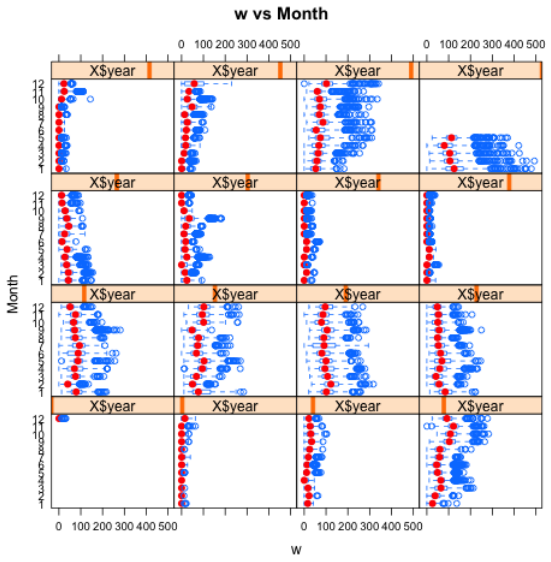

Figure 4: Box plots of raw Wolf number (w) by month and year.

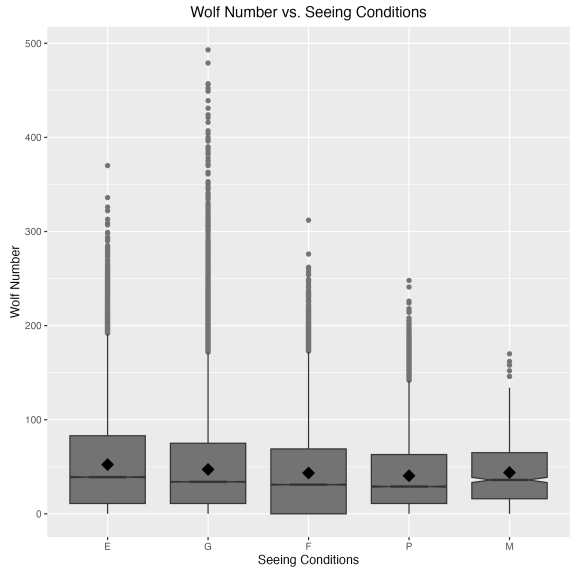

Figure 5: Box plots of raw Wolf number (w) by seeing condition.

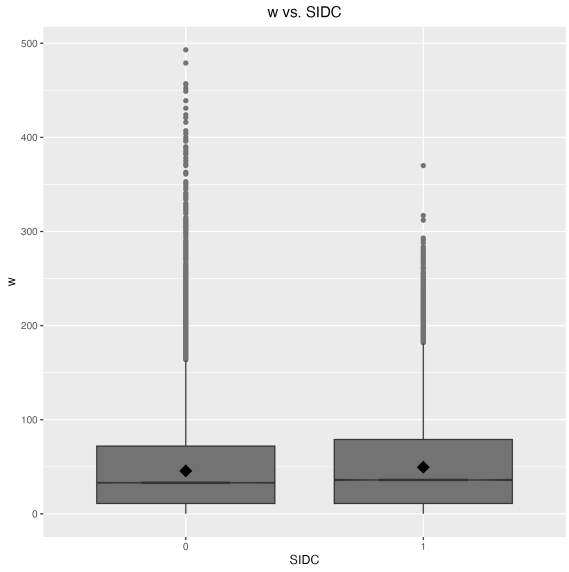

Figure 6: Box plots of raw Wolf number (w) by organization.

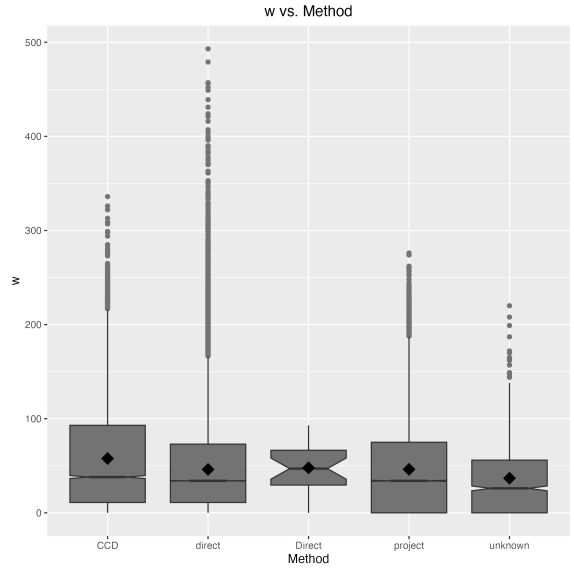

Figure 7: Box plots of raw Wolf number (w) by observer rank.

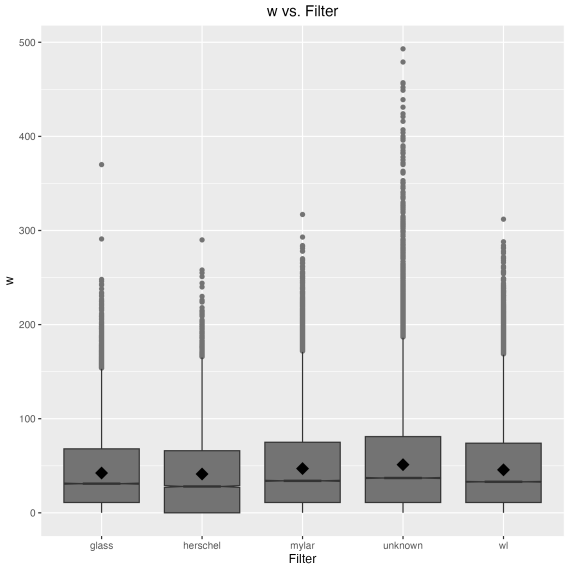

Figure 8: Box plots of raw Wolf number (w) by month and year.

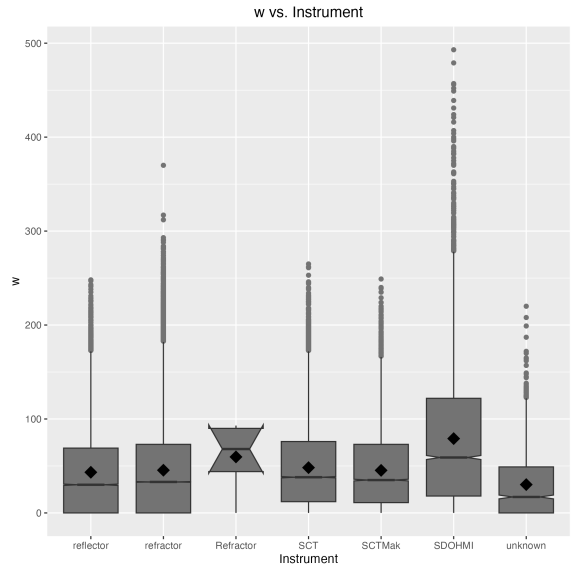

Figure 9: Box plots of raw Wolf number (w) by seeing condition.

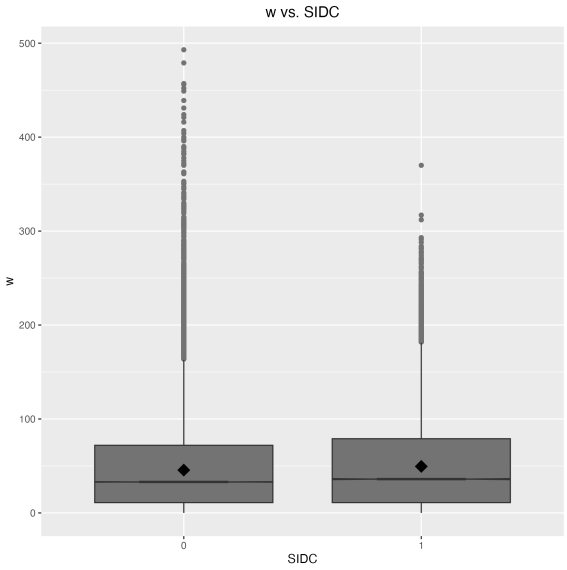

Figure 10: Box plots of raw Wolf number (w) by organization.

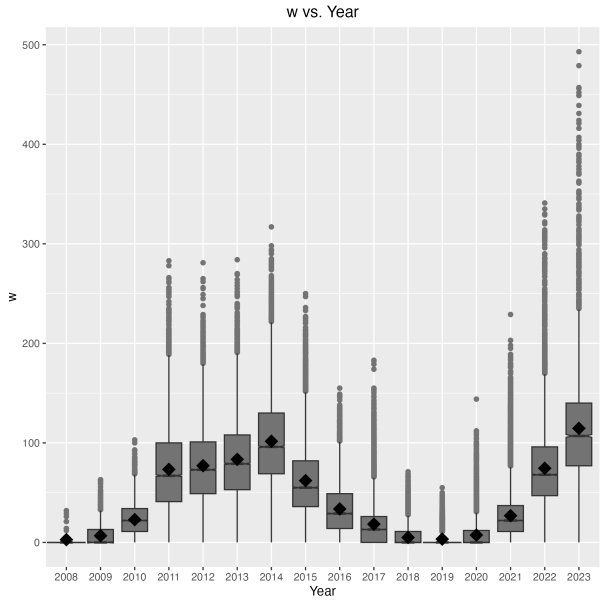

Figure 11: Box plots of raw Wolf number (w) by year.

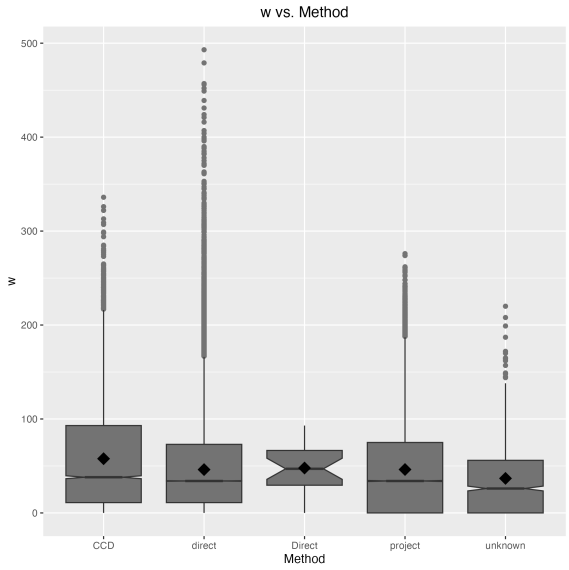

Figure 12: Box plots of raw Wolf number (w) by observing method.