

# Monthly Report (00)

## 2023.03 Data Set

Friday 14<sup>th</sup> April, 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.

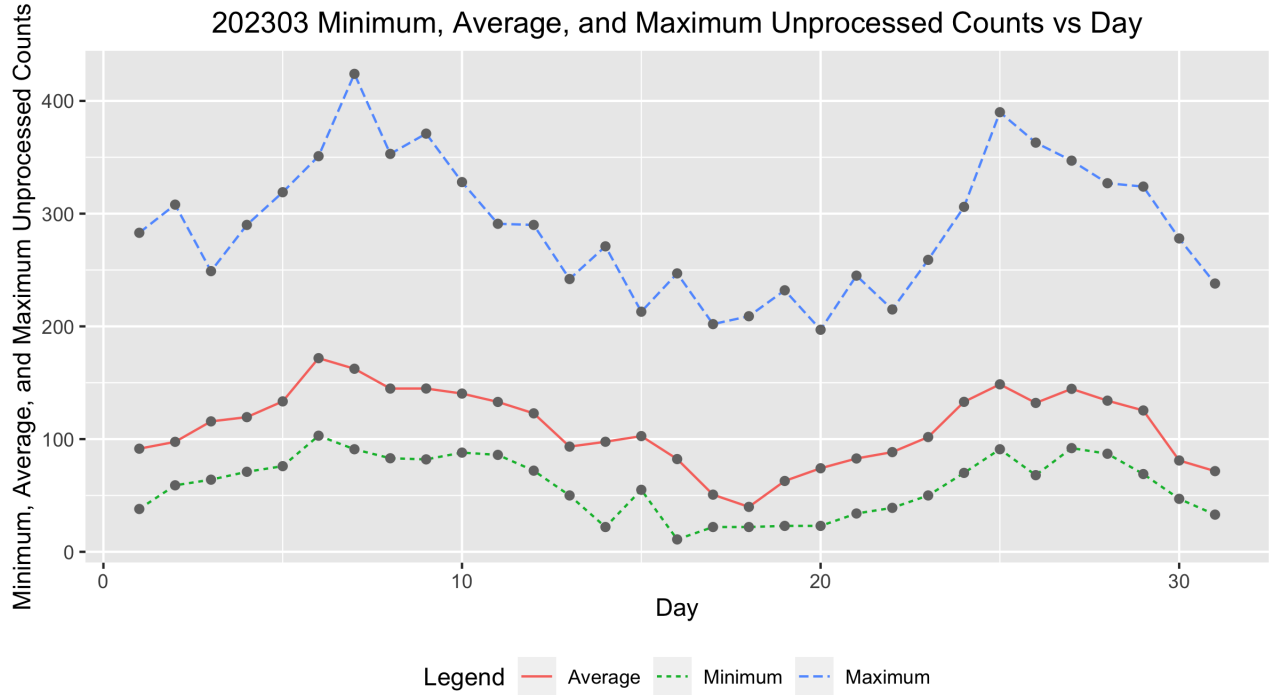


Figure 1: Raw average sunspot count by day of the month.

Table 1: 202303 Daily Raw Counts

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Day	Submissions	Minimum	Average	Maximum
1.0000	23.0000	38.0000	91.4783	283.0000
2.0000	28.0000	59.0000	97.5714	308.0000
3.0000	28.0000	64.0000	115.7143	249.0000
4.0000	29.0000	71.0000	119.4828	290.0000
5.0000	31.0000	76.0000	133.4516	319.0000
6.0000	35.0000	103.0000	171.8000	351.0000
7.0000	30.0000	91.0000	162.4000	424.0000
8.0000	28.0000	83.0000	144.8214	353.0000
9.0000	29.0000	82.0000	144.8621	371.0000
10.0000	26.0000	88.0000	140.3846	328.0000
11.0000	28.0000	86.0000	132.9643	291.0000
12.0000	36.0000	72.0000	122.8333	290.0000
13.0000	27.0000	50.0000	93.3333	242.0000
14.0000	30.0000	22.0000	97.6333	271.0000
15.0000	38.0000	55.0000	102.6579	213.0000
16.0000	25.0000	11.0000	82.2800	247.0000
17.0000	32.0000	22.0000	50.7188	202.0000
18.0000	39.0000	22.0000	39.8462	209.0000
19.0000	34.0000	23.0000	62.8529	232.0000
20.0000	32.0000	23.0000	74.1250	197.0000
21.0000	34.0000	34.0000	82.7941	245.0000
22.0000	31.0000	39.0000	88.4516	215.0000
23.0000	30.0000	50.0000	101.8000	259.0000
24.0000	32.0000	70.0000	133.0312	306.0000
25.0000	31.0000	91.0000	148.5806	390.0000
26.0000	36.0000	68.0000	132.0833	363.0000
27.0000	35.0000	92.0000	144.5714	347.0000
28.0000	32.0000	87.0000	134.0938	327.0000
29.0000	38.0000	69.0000	125.3947	324.0000
30.0000	36.0000	47.0000	81.0278	278.0000
31.0000	22.0000	33.0000	71.5909	238.0000

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### 3 Error Tables

Data are for the month of March 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<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	2.4243	3.1167	0.5000	1.0000
2009.01	5.1662	4.6324	5.7000	1.3000	1.3000
2009.02	4.6158	4.1249	5.1066	0.7000	1.2000
2009.03	5.9989	5.7768	6.2210	0.3000	0.6000
2009.04	6.8710	6.6402	7.1019	0.4000	1.2000
2009.05	7.0598	6.7933	7.3264	1.6000	2.9000
2009.06	6.3580	6.0495	6.6665	3.2000	6.3000
2009.07	6.3349	6.0872	6.5827	3.6000	5.5000
2009.08	6.6325	6.3884	6.8766	0.0000	0.0000
2009.09	7.3296	7.0829	7.5762	4.5000	7.1000
2009.10	6.8570	6.5070	7.2070	4.5000	7.7000
2009.11	6.8680	6.6762	7.0599	3.3000	6.9000
2009.12	7.3277	7.1132	7.5422	10.4000	16.3000
2010.01	19.5995	17.4747	21.7242	13.3000	19.5000
2010.02	15.8606	13.8122	17.9090	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	17.5074	15.4317	19.5830	15.4000	24.0000
2010.04	19.6989	17.4814	21.9164	7.0000	10.4000
2010.05	23.5498	23.1179	23.9817	8.4000	8.7000
2010.06	19.9131	19.5586	20.2676	11.0000	13.6000
2010.07	21.7476	21.4021	22.0930	15.2000	16.1000
2010.08	21.9316	21.5379	22.3252	18.3000	19.6000
2010.09	25.2829	24.8294	25.7364	22.8000	25.2000
2010.10	24.0152	23.5577	24.4728	21.0000	23.5000
2010.11	24.4050	23.9408	24.8691	20.9000	21.6000
2010.12	25.1132	24.5878	25.6387	13.9000	14.5000
2011.01	70.3309	68.8432	71.8187	17.7000	18.7000
2011.02	61.9489	60.5866	63.3112	29.1000	29.6000
2011.03	66.0954	64.7717	67.4192	48.0000	55.8000
2011.04	75.7093	74.2044	77.2141	47.3000	54.4000
2011.05	77.7392	76.3340	79.1445	37.3000	41.5000
2011.06	65.5329	64.3210	66.7448	35.2000	37.0000
2011.07	70.5675	69.3175	71.8175	41.5000	43.8000
2011.08	71.9772	70.7649	73.1895	42.4000	50.5000
2011.09	81.8779	80.3746	83.3813	73.8000	78.0000
2011.10	77.6410	76.2623	79.0197	78.9000	88.0000
2011.11	78.8865	77.2213	80.5518	84.6000	96.7000
2011.12	79.5383	77.8814	81.1951	65.8000	73.0000
2012.01	75.6325	74.1022	77.1627	55.8000	58.2000
2012.02	65.5037	64.1218	66.8856	29.2000	33.1000
2012.03	70.5293	69.2441	71.8145	53.1000	64.1000
2012.04	79.1951	77.7191	80.6711	51.4000	55.2000
2012.05	83.1603	81.7084	84.6122	61.8000	69.0000
2012.06	69.6008	68.3672	70.8345	59.7000	64.5000
2012.07	75.5906	74.2894	76.8918	64.2000	51.3000
2012.08	74.1678	72.9069	75.4287	57.7000	63.1000
2012.09	84.7490	83.2287	86.2693	57.7000	61.5000
2012.10	81.2616	79.7200	82.8032	48.3000	53.3000
2012.11	82.8765	81.1684	84.5845	56.7000	61.4000
2012.12	83.4971	81.6530	85.3412	37.4000	40.8000
2013.01	83.8807	82.2334	85.5280	63.8000	62.9000
2013.02	72.7548	71.2424	74.2673	37.8000	38.0000
2013.03	75.9360	74.3469	77.5251	50.6000	57.9000
2013.04	86.3287	84.7432	87.9143	70.6000	72.4000
2013.05	88.5156	86.8568	90.1743	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	75.5963	74.1863	77.0062	51.0000	52.5000
2013.07	81.1433	79.7618	82.5248	57.0000	57.0000
2013.08	81.3536	79.9754	82.7318	60.0000	66.0000
2013.09	91.3841	89.6913	93.0770	34.6000	36.9000
2013.10	86.5499	84.8869	88.2130	74.5000	85.6000
2013.11	86.8575	84.8298	88.8852	73.9000	77.6000
2013.12	89.9290	87.9713	91.8866	77.8000	90.3000
2014.01	98.0073	95.8966	100.1180	77.4000	82.0000
2014.02	86.8848	85.0962	88.6735	93.9000	102.8000
2014.03	92.6647	90.9165	94.4128	80.9000	92.2000
2014.04	105.4970	103.5640	107.4301	76.9000	84.7000
2014.05	108.7711	106.8446	110.6977	72.3000	75.2000
2014.06	92.7717	91.1240	94.4193	67.2000	71.0000
2014.07	99.1761	97.4353	100.9169	72.5000	72.5000
2014.08	99.4911	97.8684	101.1139	71.2000	74.7000
2014.09	113.0801	110.9976	115.1626	83.2000	87.6000
2014.10	106.5537	104.5313	108.5761	59.5000	60.6000
2014.11	108.0029	105.6801	110.3257	65.8000	71.1000
2014.12	109.1417	106.5928	111.6907	75.8000	78.0000
2015.01	60.5719	59.3436	61.8002	65.9000	67.0000
2015.02	52.5055	51.2993	53.7116	42.4000	44.8000
2015.03	56.7590	55.6863	57.8317	38.0000	38.4000
2015.04	64.2939	63.0896	65.4982	49.0000	54.4000
2015.05	66.3293	65.1907	67.4678	56.3000	58.8000
2015.06	56.2519	55.2303	57.2735	50.2000	68.3000
2015.07	59.5060	58.4944	60.5177	47.9000	65.8000
2015.08	60.8976	59.8763	61.9189	39.5000	57.2000
2015.09	68.5054	67.2583	69.7524	49.2000	72.1000
2015.10	65.0003	63.7435	66.2570	39.3000	48.3000
2015.11	66.4555	64.9971	67.9139	39.6000	55.9000
2015.12	67.7263	66.2104	69.2421	36.4000	44.8000
2016.01	33.1460	32.4512	33.8408	33.7000	43.3000
2016.02	28.7362	28.1339	29.3386	38.3000	46.8000
2016.03	30.6152	29.9998	31.2307	30.5000	38.9000
2016.04	34.4778	33.8161	35.1395	26.6000	30.9000
2016.05	35.7232	35.0681	36.3783	33.7000	48.4000
2016.06	30.0545	29.5389	30.5702	13.1000	19.5000
2016.07	32.4623	31.9389	32.9857	21.2000	27.5000
2016.08	32.8149	32.2349	33.3949	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	37.7715	37.0789	38.4640	27.7000	37.1000
2016.10	35.5407	34.8538	36.2276	22.7000	31.7000
2016.11	35.9424	35.1880	36.6969	14.0000	22.2000
2016.12	37.0924	36.2915	37.8933	11.1000	20.0000
2017.01	17.8585	17.4790	18.2379	18.4000	26.2000
2017.02	15.5425	15.1984	15.8866	14.4000	20.6000
2017.03	16.6837	16.3634	17.0041	11.3000	15.5000
2017.04	18.9746	18.6376	19.3115	21.6000	33.2000
2017.05	19.4016	19.0643	19.7389	12.5000	18.1000
2017.06	16.2740	16.0028	16.5453	15.5000	19.3000
2017.07	17.6551	17.3714	17.9388	11.5000	16.3000
2017.08	17.8092	17.4975	18.1209	22.8000	35.7000
2017.09	20.8263	20.3901	21.2625	34.6000	42.9000
2017.10	19.0720	18.6794	19.4647	10.5000	11.0000
2017.11	19.1753	18.7676	19.5831	4.2000	5.6000
2017.12	19.6854	19.3841	19.9867	4.0000	4.6000
2018.01	4.9917	4.8846	5.0988	3.1000	6.3000
2018.02	4.3033	4.1989	4.4077	6.8000	11.8000
2018.03	4.5474	4.4553	4.6394	1.1000	1.2000
2018.04	5.1150	5.0124	5.2176	4.7000	7.5000
2018.05	5.3030	5.2043	5.4018	8.4000	14.0000
2018.06	4.4693	4.3907	4.5479	10.2000	13.6000
2018.07	4.8561	4.8015	4.9107	0.5000	1.7000
2018.08	4.8435	4.7606	4.9264	5.9000	9.5000
2018.09	5.4575	5.3553	5.5596	1.6000	2.9000
2018.10	5.2638	5.1607	5.3669	2.5000	5.6000
2018.11	5.3055	5.1945	5.4165	3.1000	4.2000
2018.12	5.5482	5.4400	5.6564	1.6000	2.3000
2019.01	3.3056	3.2427	3.3685	5.4000	2.3000
2019.02	2.9081	2.8509	2.9653	0.1000	1.2000
2019.03	3.0407	2.9892	3.0923	6.1000	12.1000
2019.04	3.4560	3.3911	3.5209	6.2000	9.3000
2019.05	3.4742	3.4138	3.5345	7.0000	11.9000
2019.06	2.9396	2.8902	2.9891	0.7000	1.5000
2019.07	3.1875	3.1404	3.2346	0.4000	2.2000
2019.08	3.2313	3.1835	3.2790	0.3000	0.8000
2019.09	3.7179	3.6598	3.7760	0.5000	1.0000
2019.10	3.4799	3.4209	3.5388	0.2000	0.5000
2019.11	3.5872	3.5185	3.6558	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	3.6550	3.5826	3.7274	0.8000	1.0000
2020.01	7.3149	7.1719	7.4580	4.0000	5.3000
2020.02	6.3684	6.2409	6.4959	0.1000	0.0000
2020.03	6.7181	6.5928	6.8434	1.2000	1.5000
2020.04	7.6884	7.5627	7.8141	3.0000	5.1000
2020.05	7.7902	7.6694	7.9111	0.1000	0.4000
2020.06	6.6339	6.5326	6.7351	3.9000	6.4000
2020.07	7.0888	6.9849	7.1926	4.2000	7.7000
2020.08	7.0805	6.9825	7.1785	5.3000	7.8000
2020.09	8.1200	7.9902	8.2498	0.4000	0.9000
2020.10	7.7823	7.6545	7.9102	9.9000	13.6000
2020.11	7.9413	7.8128	8.0698	21.2000	33.1000
2020.12	8.1197	7.9743	8.2650	15.4000	19.8000
2021.01	25.5784	25.1230	26.0337	7.0000	15.8000
2021.02	22.6512	22.2487	23.0537	5.8000	10.7000
2021.03	24.0516	23.6714	24.4318	11.0000	17.2000
2021.04	27.6194	27.1580	28.0807	18.5000	28.8000
2021.05	28.3030	27.8712	28.7347	15.9000	22.9000
2021.06	23.9349	23.5604	24.3093	19.9000	24.1000
2021.07	25.5099	25.0899	25.9299	23.8000	35.6000
2021.08	26.3520	25.9220	26.7820	15.7000	19.5000
2021.09	29.8735	29.3671	30.3798	39.1000	52.5000
2021.10	28.9643	28.4609	29.4678	27.1000	37.0000
2021.11	29.1671	28.6588	29.6755	27.2000	35.1000
2021.12	30.6302	30.0350	31.2255	50.6000	69.0000
2022.01	72.7579	71.4828	74.0330	43.9000	62.0000
2022.02	64.2256	63.0634	65.3878	48.8000	60.5000
2022.03	68.9434	67.7113	70.1755	58.4000	80.6000
2022.04	75.8407	74.6358	77.0456	59.1000	83.9000
2022.05	80.5368	79.2488	81.8247	72.5000	0.4000
2022.06	66.2453	65.1992	67.2914	58.9000	0.4000
2022.07	72.5555	71.3737	73.7374	76.7000	102.5000
2022.08	73.2356	72.0622	74.4090	63.3000	86.0000
2022.09	82.7700	81.2570	84.2831	72.6000	94.5000
2022.10	78.6065	77.2309	79.9821	66.4000	112.1000
2022.11	79.4027	77.8967	80.9087	54.3000	82.1000
2022.12	81.8675	80.1653	83.5697	93.7000	165.0000
2023.01	132.0575	129.2728	134.8422	112.9000	173.8000
2023.02	113.8264	111.4960	116.1569	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	118.2009	115.8156	120.5863	85.0000	126.8000

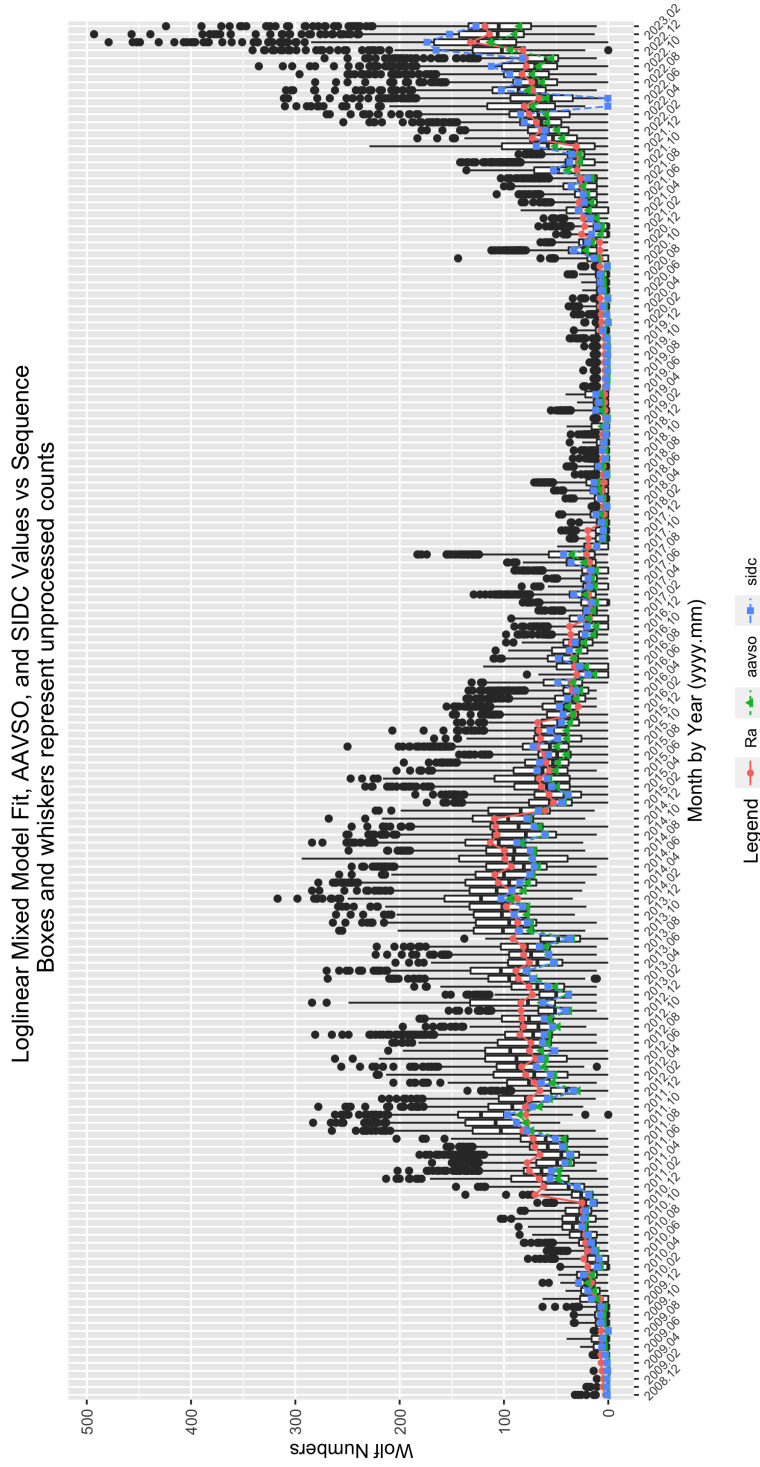


Figure 2: GLMM fitted data for  $R_a$ . AAVSO data: <https://www.aavso.org/category/tags/solar-bulletin>. SILSO data: WDC-SILSO, Royal Observatory of Belgium, Brussels

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: 202303 Parameter Estimates

	Estimate	Std. Error	t-value	Pr(> t )
(Intercept)	1.1980	0.3155	3.7968	0.0001
seeF	-0.2301	0.0052	-44.0861	0.0000
seeG	-0.1173	0.0046	-25.6976	0.0000
seeM	-0.1872	0.0243	-7.6882	0.0000
seeP	-0.3235	0.0075	-43.2801	0.0000
sidc1	0.0503	0.0126	4.0063	0.0001
year2009	0.7631	0.3170	2.4071	0.0161
year2010	2.0017	0.3148	6.3583	0.0000
year2011	3.1451	0.3147	9.9936	0.0000
year2012	3.1867	0.3147	10.1259	0.0000
year2013	3.2815	0.3147	10.4273	0.0000
year2014	3.4804	0.3147	11.0596	0.0000
year2015	2.9989	0.3147	9.5292	0.0000
year2016	2.3836	0.3147	7.5732	0.0000
year2017	1.7696	0.3148	5.6217	0.0000
year2018	0.4881	0.3151	1.5491	0.1214
year2019	0.0733	0.3153	0.2325	0.8161
year2020	0.8790	0.3149	2.7911	0.0053
year2021	2.1600	0.3148	6.8624	0.0000
year2022	3.1513	0.3147	10.0128	0.0000
year2023	3.7259	0.3148	11.8356	0.0000
mon2	-0.1339	0.0077	-17.3706	0.0000
mon3	-0.0753	0.0073	-10.3373	0.0000
mon4	0.0415	0.0075	5.5683	0.0000
mon5	0.0656	0.0073	9.0026	0.0000
mon6	-0.1040	0.0076	-13.6562	0.0000
mon7	-0.0363	0.0074	-4.9230	0.0000
mon8	-0.0249	0.0073	-3.4171	0.0006
mon9	0.1127	0.0073	15.4564	0.0000
mon10	0.0616	0.0075	8.2657	0.0000
mon11	0.0887	0.0077	11.4516	0.0000
mon12	0.1164	0.0077	15.0861	0.0000

Table 4: 202303 Summary of Sunspot Numbers

year	mon	day	obs	sidc
Min. :2008	Min. : 1.000	Min. : 0.00	Length:166511	Min. :0.0000
1st Qu.:2013	1st Qu.: 4.000	1st Qu.: 8.00	Class :character	1st Qu.:0.0000
Median :2017	Median : 7.000	Median :16.00	Mode :character	Median :0.0000
Mean :2016	Mean : 6.566	Mean :15.71		Mean :0.2439
3rd Qu.:2020	3rd Qu.: 9.000	3rd Qu.:23.00		3rd Qu.:0.0000
Max. :2023	Max. :12.000	Max. :31.00		Max. :1.0000

Table 5: 202303 Summary of Sunspot Numbers

g	s	w	see	method
Min. : 0.000	Min. : 0.00	Min. : 0.00	Length:166511	Length:166511
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 : 2.904	Mean : 16.75	Mean : 45.79		
3rd Qu.: 5.000	3rd Qu.: 25.00	3rd Qu.: 73.00		
Max. :30.000	Max. :262.00	Max. :493.00		

Table 6: 202303 Summary of Sunspot Numbers

inst	filter	unit
Length:166511	Length:166511	Length:166511
Class :character	Class :character	Class :character
Mode :character	Mode :character	Mode :character

Table 7: 202303 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 : 92.68	Mean : 37.69	Mean : 890.5	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

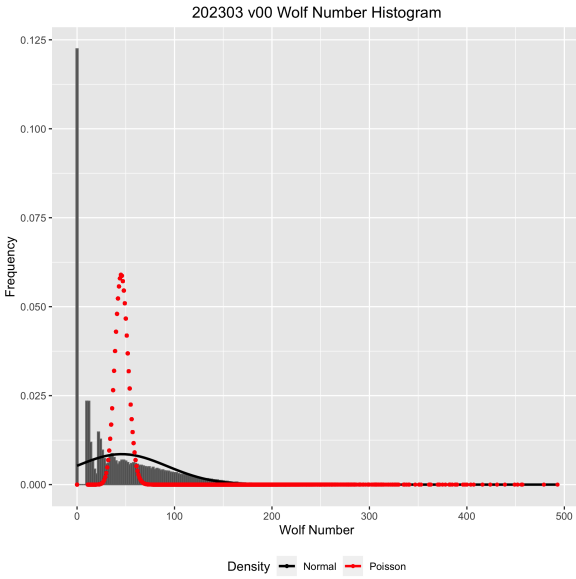


Figure 3: Box plots of raw Wolf number (w) by observer rank.

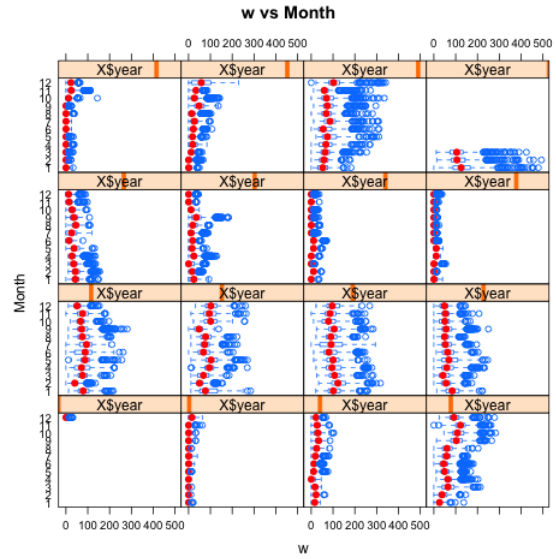


Figure 4: Box plots of raw Wolf number (w) by month and year.

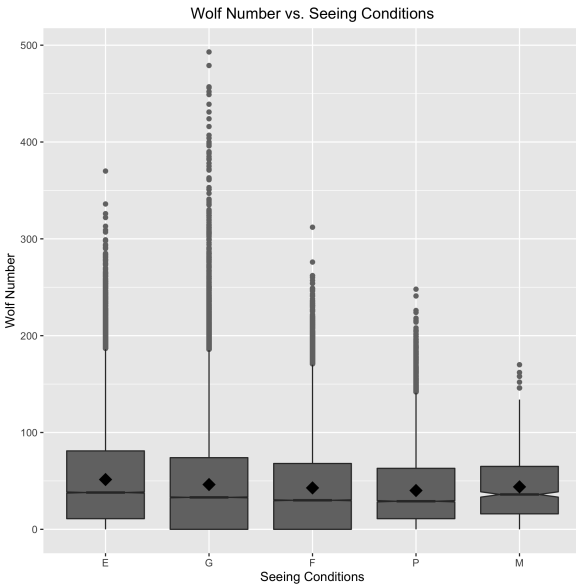


Figure 5: Box plots of raw Wolf number (w) by seeing condition.

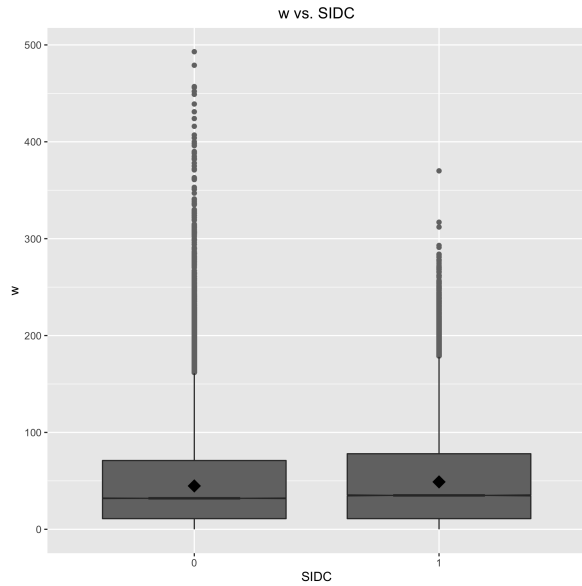


Figure 6: Box plots of raw Wolf number (w) by organization.



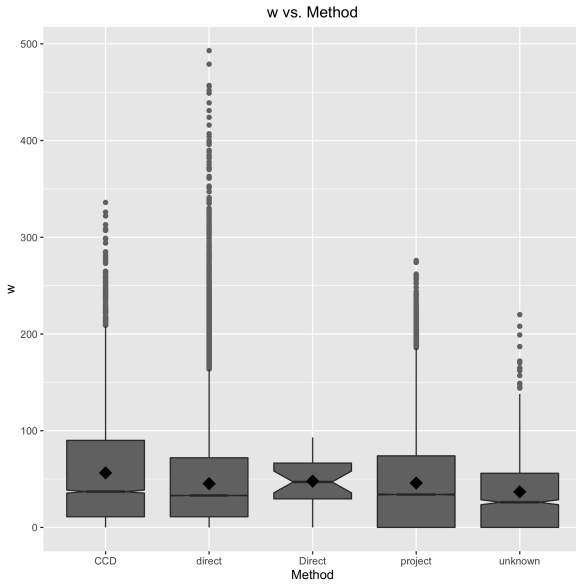


Figure 7: Box plots of raw Wolf number (w) by observer rank.

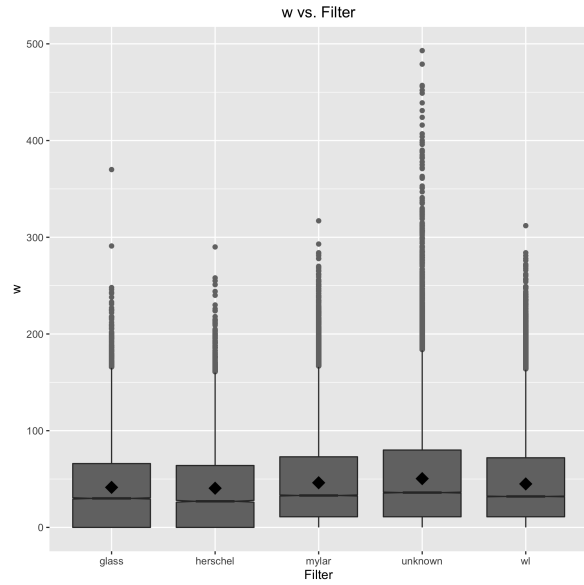


Figure 8: Box plots of raw Wolf number (w) by month and year.

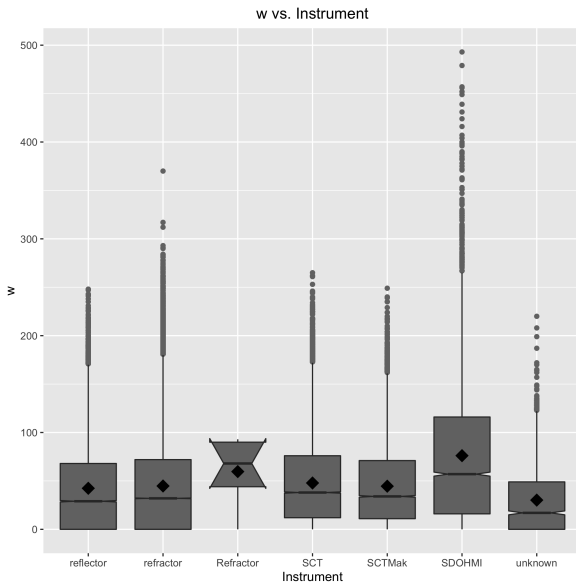


Figure 9: Box plots of raw Wolf number (w) by seeing condition.

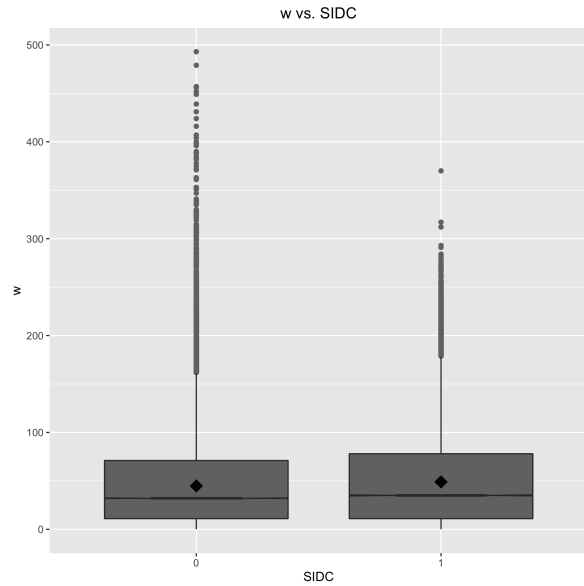


Figure 10: Box plots of raw Wolf number (w) by organization.

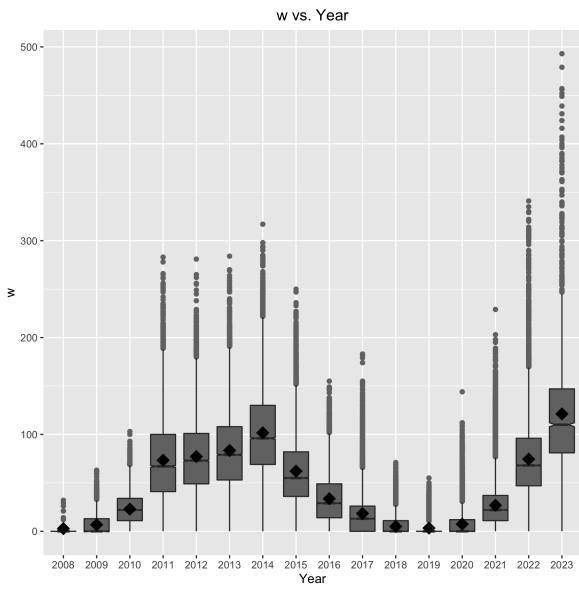


Figure 11: Box plots of raw Wolf number (w) by year.

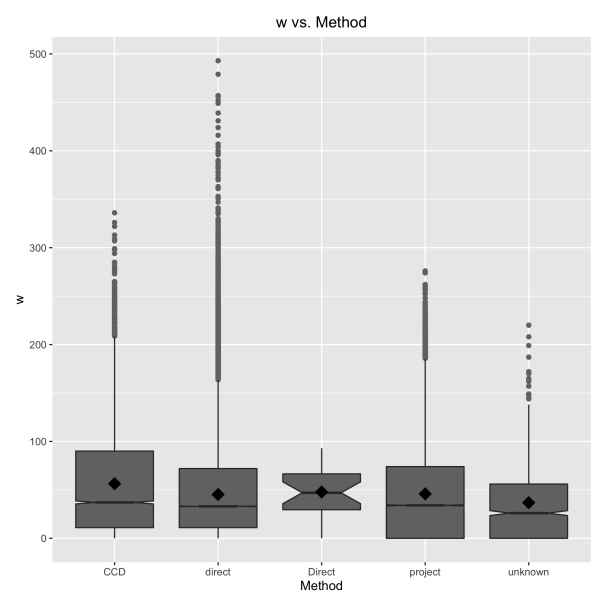


Figure 12: Box plots of raw Wolf number (w) by observing method.