

**Monthly Report (00)**  
**202210 Data Set**

**Sunday 13<sup>th</sup> November, 2022**

**Prepared for**

**Statistics for Physical and Engineering Sciences**

**by**

**Jamie Riggs, Ph.D.**

Principal Statistician  
Statistics for Physical and Engineering Sciences Institute



## 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.

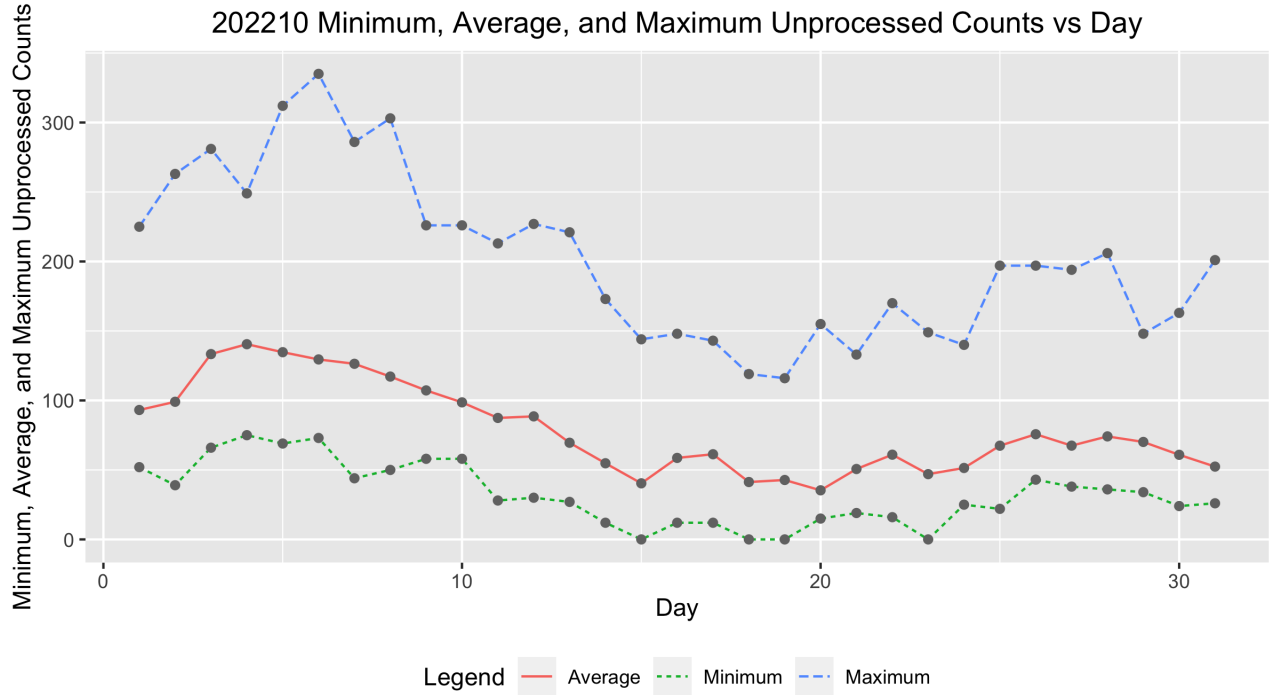


Figure 1: Raw average sunspot count by day of the month.

Table 1: 202210 Daily Raw Counts

Day	Submissions	Minimum	Average	Maximum
1.0000	37.0000	52.0000	93.1351	225.0000
2.0000	47.0000	39.0000	99.0426	263.0000
3.0000	43.0000	66.0000	133.3721	281.0000
4.0000	40.0000	75.0000	140.4750	249.0000
5.0000	37.0000	69.0000	134.7297	312.0000
6.0000	39.0000	73.0000	129.5128	335.0000
7.0000	35.0000	44.0000	126.3714	286.0000
8.0000	42.0000	50.0000	117.1905	303.0000
9.0000	41.0000	58.0000	107.2195	226.0000
10.0000	35.0000	58.0000	98.6286	226.0000
11.0000	43.0000	28.0000	87.4186	213.0000
12.0000	37.0000	30.0000	88.5405	227.0000
13.0000	34.0000	27.0000	69.5588	221.0000
14.0000	37.0000	12.0000	54.8108	173.0000
15.0000	39.0000	0.0000	40.3590	144.0000
16.0000	42.0000	12.0000	58.6429	148.0000
17.0000	34.0000	12.0000	61.2941	143.0000
18.0000	37.0000	0.0000	41.2973	119.0000
19.0000	34.0000	0.0000	42.7647	116.0000
20.0000	33.0000	15.0000	35.3333	155.0000
21.0000	33.0000	19.0000	50.6667	133.0000
22.0000	40.0000	16.0000	60.9750	170.0000
23.0000	33.0000	0.0000	46.9697	149.0000
24.0000	29.0000	25.0000	51.4138	140.0000
25.0000	34.0000	22.0000	67.4412	197.0000
26.0000	37.0000	43.0000	75.7027	197.0000
27.0000	40.0000	38.0000	67.4750	194.0000
28.0000	38.0000	36.0000	74.1316	206.0000
29.0000	43.0000	34.0000	70.1395	148.0000
30.0000	38.0000	24.0000	60.8947	163.0000
31.0000	31.0000	26.0000	52.3871	201.0000

### 3 Error Tables

Data are for the month of October 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	2.4235	3.1175	0.5000	1.0000
2009.01	5.1712	4.6355	5.7070	1.3000	1.3000
2009.02	4.6003	4.1100	5.0906	0.7000	1.2000
2009.03	6.1302	5.9032	6.3572	0.3000	0.6000
2009.04	6.9194	6.6866	7.1522	0.4000	1.2000
2009.05	7.1114	6.8447	7.3781	1.6000	2.9000
2009.06	6.3906	6.0807	6.7005	3.2000	6.3000
2009.07	6.3765	6.1279	6.6252	3.6000	5.5000
2009.08	6.6688	6.4250	6.9125	0.0000	0.0000
2009.09	7.3785	7.1301	7.6270	4.5000	7.1000
2009.10	6.9032	6.5515	7.2548	4.5000	7.7000
2009.11	7.0974	6.9029	7.2919	3.3000	6.9000
2009.12	7.0001	6.8006	7.1996	10.4000	16.3000
2010.01	19.5428	17.4169	21.6687	13.3000	19.5000
2010.02	15.7545	13.7125	17.7964	19.4000	28.5000

Continued on next page

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

ym	Ra	lci99	uci99	aavso	sidc
2010.03	17.7912	15.6791	19.9034	15.4000	24.0000
2010.04	19.7552	17.5281	21.9824	7.0000	10.4000
2010.05	23.6206	23.1990	24.0421	8.4000	8.7000
2010.06	19.9536	19.6113	20.2959	11.0000	13.6000
2010.07	21.7868	21.4575	22.1161	15.2000	16.1000
2010.08	21.9732	21.5976	22.3488	18.3000	19.6000
2010.09	25.3240	24.8926	25.7554	22.8000	25.2000
2010.10	24.0244	23.5927	24.4561	21.0000	23.5000
2010.11	25.1622	24.6981	25.6263	20.9000	21.6000
2010.12	23.9284	23.4441	24.4126	13.9000	14.5000
2011.01	70.0825	68.6443	71.5207	17.7000	18.7000
2011.02	61.4440	60.1375	62.7504	29.1000	29.6000
2011.03	67.1832	65.8821	68.4844	48.0000	55.8000
2011.04	75.7679	74.3398	77.1960	47.3000	54.4000
2011.05	77.8117	76.4643	79.1592	37.3000	41.5000
2011.06	65.6055	64.4350	66.7759	35.2000	37.0000
2011.07	70.7084	69.4891	71.9277	41.5000	43.8000
2011.08	72.1059	70.9302	73.2816	42.4000	50.5000
2011.09	81.9459	80.4973	83.3944	73.8000	78.0000
2011.10	77.7252	76.3934	79.0571	78.9000	88.0000
2011.11	81.3153	79.6282	83.0024	84.6000	96.7000
2011.12	75.8269	74.2724	77.3813	65.8000	73.0000
2012.01	75.3001	73.8066	76.7935	55.8000	58.2000
2012.02	64.9228	63.5847	66.2610	29.2000	33.1000
2012.03	71.6576	70.3789	72.9363	53.1000	64.1000
2012.04	79.3310	77.9001	80.7618	51.4000	55.2000
2012.05	83.2797	81.8738	84.6856	61.8000	69.0000
2012.06	69.6359	68.4390	70.8328	59.7000	64.5000
2012.07	75.6605	74.4000	76.9210	64.2000	51.3000
2012.08	74.2787	73.0579	75.4996	57.7000	63.1000
2012.09	84.8680	83.3775	86.3586	57.7000	61.5000
2012.10	81.3282	79.8202	82.8361	48.3000	53.3000
2012.11	85.3081	83.5798	87.0365	56.7000	61.4000
2012.12	79.5934	77.8557	81.3310	37.4000	40.8000
2013.01	83.5734	81.9580	85.1888	63.8000	62.9000
2013.02	72.1904	70.7182	73.6627	37.8000	38.0000
2013.03	77.2163	75.6240	78.8086	50.6000	57.9000
2013.04	86.5198	84.9674	88.0722	70.6000	72.4000
2013.05	88.6996	87.0821	90.3170	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	75.6850	74.3153	77.0548	51.0000	52.5000
2013.07	81.2367	79.8949	82.5784	57.0000	57.0000
2013.08	81.4793	80.1360	82.8226	60.0000	66.0000
2013.09	91.5402	89.8781	93.2023	34.6000	36.9000
2013.10	86.6842	85.0507	88.3176	74.5000	85.6000
2013.11	89.4100	87.3626	91.4573	73.9000	77.6000
2013.12	85.7316	83.8846	87.5787	77.8000	90.3000
2014.01	97.5745	95.4989	99.6501	77.4000	82.0000
2014.02	86.0678	84.3360	87.7996	93.9000	102.8000
2014.03	94.1272	92.3836	95.8707	80.9000	92.2000
2014.04	105.6194	103.7309	107.5079	76.9000	84.7000
2014.05	108.9105	107.0227	110.7983	72.3000	75.2000
2014.06	92.7955	91.1926	94.3984	67.2000	71.0000
2014.07	99.2136	97.5199	100.9072	72.5000	72.5000
2014.08	99.5950	98.0116	101.1783	71.2000	74.7000
2014.09	113.1851	111.1510	115.2193	83.2000	87.6000
2014.10	106.6883	104.6998	108.6769	59.5000	60.6000
2014.11	111.1759	108.8290	113.5228	65.8000	71.1000
2014.12	104.1372	101.7159	106.5584	75.8000	78.0000
2015.01	60.2811	59.0682	61.4940	65.9000	67.0000
2015.02	51.9747	50.8063	53.1431	42.4000	44.8000
2015.03	57.6036	56.5352	58.6720	38.0000	38.4000
2015.04	64.2930	63.1207	65.4653	49.0000	54.4000
2015.05	66.4106	65.2946	67.5266	56.3000	58.8000
2015.06	56.3529	55.3382	57.3676	50.2000	68.3000
2015.07	59.6665	58.6551	60.6778	47.9000	65.8000
2015.08	61.0661	60.0456	62.0865	39.5000	57.2000
2015.09	68.6589	67.4136	69.9042	49.2000	72.1000
2015.10	65.1503	63.8939	66.4067	39.3000	48.3000
2015.11	68.5089	67.0131	70.0046	39.6000	55.9000
2015.12	64.5456	63.1107	65.9806	36.4000	44.8000
2016.01	32.9921	32.3035	33.6806	33.7000	43.3000
2016.02	28.4845	27.8896	29.0795	38.3000	46.8000
2016.03	31.0946	30.4726	31.7165	30.5000	38.9000
2016.04	34.5417	33.8819	35.2016	26.6000	30.9000
2016.05	35.8215	35.1673	36.4757	33.7000	48.4000
2016.06	30.1072	29.5933	30.6212	13.1000	19.5000
2016.07	32.5168	31.9954	33.0382	21.2000	27.5000
2016.08	32.8925	32.3143	33.4706	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	37.8456	37.1551	38.5360	27.7000	37.1000
2016.10	35.5995	34.9145	36.2844	22.7000	31.7000
2016.11	37.0195	36.2454	37.7936	14.0000	22.2000
2016.12	35.3201	34.5608	36.0793	11.1000	20.0000
2017.01	17.8323	17.4554	18.2092	18.4000	26.2000
2017.02	15.4582	15.1175	15.7988	14.4000	20.6000
2017.03	17.0076	16.6827	17.3325	11.3000	15.5000
2017.04	19.0780	18.7410	19.4151	21.6000	33.2000
2017.05	19.5085	19.1709	19.8461	12.5000	18.1000
2017.06	16.3542	16.0825	16.6259	15.5000	19.3000
2017.07	17.7397	17.4557	18.0238	11.5000	16.3000
2017.08	17.9048	17.5924	18.2172	22.8000	35.7000
2017.09	20.9367	20.4997	21.3736	34.6000	42.9000
2017.10	19.1749	18.7805	19.5693	10.5000	11.0000
2017.11	19.8151	19.3942	20.2360	4.2000	5.6000
2017.12	18.7997	18.5123	19.0872	4.0000	4.6000
2018.01	4.9723	4.8660	5.0787	3.1000	6.3000
2018.02	4.2669	4.1633	4.3705	6.8000	11.8000
2018.03	4.6182	4.5247	4.7118	1.1000	1.2000
2018.04	5.1235	5.0207	5.2264	4.7000	7.5000
2018.05	5.3157	5.2164	5.4151	8.4000	14.0000
2018.06	4.4782	4.3994	4.5571	10.2000	13.6000
2018.07	4.8612	4.8064	4.9160	0.5000	1.7000
2018.08	4.8533	4.7703	4.9362	5.9000	9.5000
2018.09	5.4661	5.3638	5.5685	1.6000	2.9000
2018.10	5.2740	5.1704	5.3776	2.5000	5.6000
2018.11	5.4666	5.3522	5.5810	3.1000	4.2000
2018.12	5.2885	5.1852	5.3918	1.6000	2.3000
2019.01	3.2882	3.2255	3.3510	5.4000	2.3000
2019.02	2.8846	2.8280	2.9412	0.1000	1.2000
2019.03	3.0864	3.0340	3.1387	6.1000	12.1000
2019.04	3.4609	3.3959	3.5258	6.2000	9.3000
2019.05	3.4791	3.4188	3.5395	7.0000	11.9000
2019.06	2.9437	2.8943	2.9932	0.7000	1.5000
2019.07	3.1908	3.1436	3.2380	0.4000	2.2000
2019.08	3.2361	3.1883	3.2840	0.3000	0.8000
2019.09	3.7257	3.6675	3.7839	0.5000	1.0000
2019.10	3.4870	3.4277	3.5462	0.2000	0.5000
2019.11	3.6923	3.6216	3.7631	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	3.4776	3.4089	3.5463	0.8000	1.0000
2020.01	7.2778	7.1353	7.4202	4.0000	5.3000
2020.02	6.3134	6.1866	6.4402	0.1000	0.0000
2020.03	6.8203	6.6928	6.9479	1.2000	1.5000
2020.04	7.6936	7.5673	7.8200	3.0000	5.1000
2020.05	7.8042	7.6825	7.9259	0.1000	0.4000
2020.06	6.6424	6.5411	6.7437	3.9000	6.4000
2020.07	7.0959	6.9922	7.1996	4.2000	7.7000
2020.08	7.0900	6.9919	7.1881	5.3000	7.8000
2020.09	8.1353	8.0051	8.2654	0.4000	0.9000
2020.10	7.7995	7.6712	7.9278	9.9000	13.6000
2020.11	8.1832	8.0511	8.3153	21.2000	33.1000
2020.12	7.7332	7.5945	7.8720	15.4000	19.8000
2021.01	25.4666	25.0115	25.9217	7.0000	15.8000
2021.02	22.4485	22.0467	22.8503	5.8000	10.7000
2021.03	24.4236	24.0342	24.8129	11.0000	17.2000
2021.04	27.5734	27.1354	28.0113	18.5000	28.8000
2021.05	28.2798	27.8665	28.6931	15.9000	22.9000
2021.06	23.9494	23.5931	24.3058	19.9000	24.1000
2021.07	25.5377	25.1355	25.9399	23.8000	35.6000
2021.08	26.3406	25.9260	26.7551	15.7000	19.5000
2021.09	29.9254	29.4425	30.4084	39.1000	52.5000
2021.10	28.9596	28.4708	29.4484	27.1000	37.0000
2021.11	30.1928	29.6969	30.6887	27.2000	35.1000
2021.12	29.2961	28.7586	29.8336	50.6000	69.0000
2022.01	71.5789	70.3708	72.7870	43.9000	62.0000
2022.02	62.9443	61.8445	64.0441	48.8000	60.5000
2022.03	69.0778	67.8861	70.2694	58.4000	80.6000
2022.04	75.2938	74.1490	76.4385	59.1000	83.9000
2022.05	79.7905	78.5469	81.0342	72.5000	0.4000
2022.06	65.8088	64.8023	66.8154	58.9000	0.4000
2022.07	71.8800	70.7384	73.0217	76.7000	102.5000
2022.08	72.4684	71.3306	73.6063	63.3000	86.0000
2022.09	81.8276	80.3818	83.2734	72.6000	94.5000
2022.10	77.9283	76.6259	79.2308	66.4000	112.1000

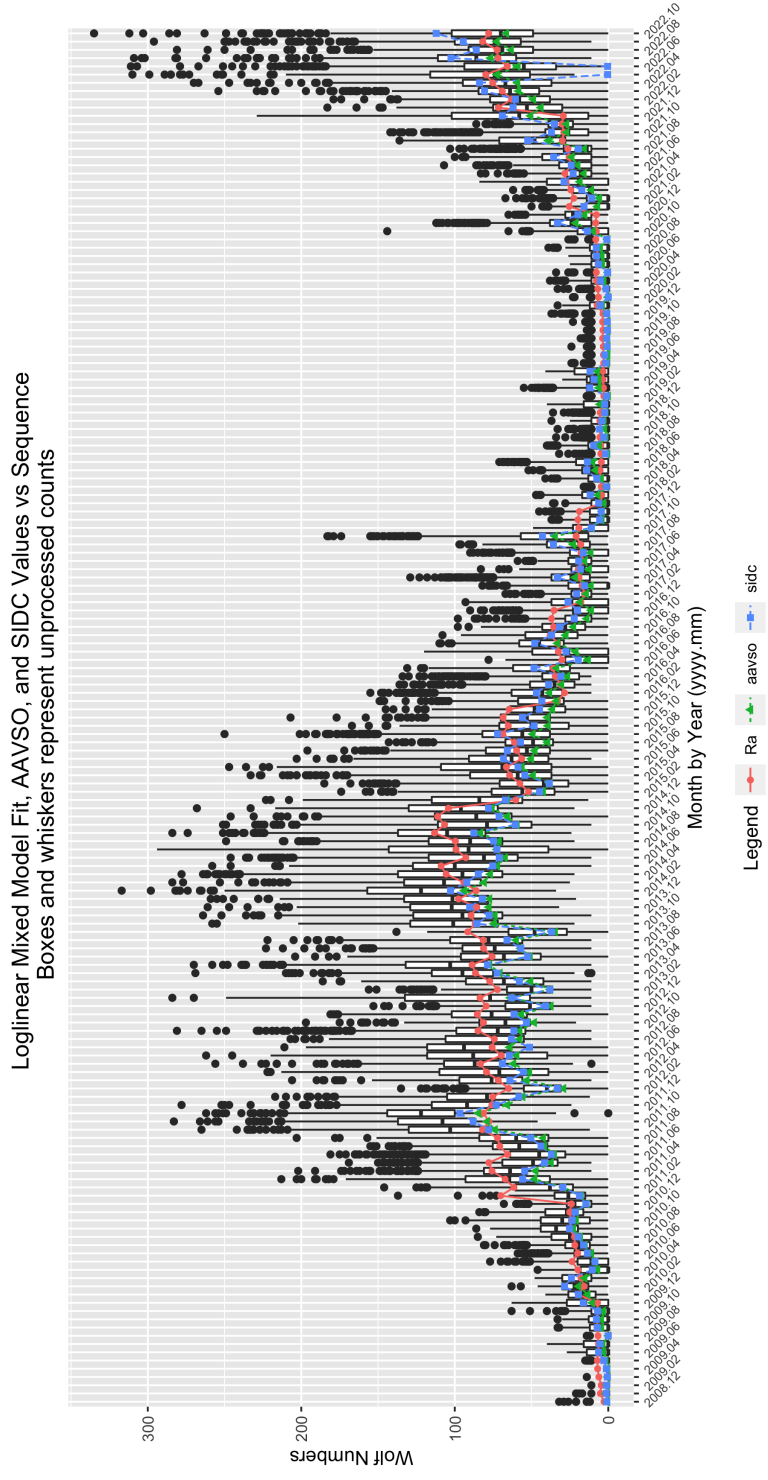


Figure 2: GLMM fitted data for  $R_a$ . AAVSO data: <https://www.aavso.org/category/tags/solar-bulletin>. SILSO data: WDC-SILSO, Royal Observatory of Belgium, Brussels

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: 202210 Parameter Estimates

	Estimate	Std. Error	t-value	Pr(> t )
(Intercept)	1.2460	0.3157	3.9464	0.0001
seeF	-0.2260	0.0054	-42.0413	0.0000
seeG	-0.1196	0.0047	-25.5020	0.0000
seeM	-0.1895	0.0244	-7.7731	0.0000
seeP	-0.3238	0.0077	-41.8639	0.0000
sidc1	0.0525	0.0138	3.8106	0.0001
year2009	0.7204	0.3172	2.2713	0.0231
year2010	1.9548	0.3150	6.2065	0.0000
year2011	3.0975	0.3149	9.8375	0.0000
year2012	3.1382	0.3149	9.9669	0.0000
year2013	3.2336	0.3149	10.2701	0.0000
year2014	3.4317	0.3149	10.8994	0.0000
year2015	2.9485	0.3149	9.3642	0.0000
year2016	2.3324	0.3149	7.4068	0.0000
year2017	1.7214	0.3149	5.4657	0.0000
year2018	0.4368	0.3152	1.3856	0.1659
year2019	0.0197	0.3154	0.0625	0.9501
year2020	0.8254	0.3151	2.6196	0.0088
year2021	2.1061	0.3149	6.6880	0.0000
year2022	3.0834	0.3149	9.7917	0.0000
mon2	-0.1378	0.0086	-16.0391	0.0000
mon3	-0.0548	0.0080	-6.8152	0.0000
mon4	0.0485	0.0077	6.2788	0.0000
mon5	0.0730	0.0076	9.6367	0.0000
mon6	-0.0975	0.0079	-12.3470	0.0000
mon7	-0.0295	0.0077	-3.8535	0.0001
mon8	-0.0178	0.0076	-2.3492	0.0188
mon9	0.1194	0.0076	15.7530	0.0000
mon10	0.0679	0.0077	8.7726	0.0000
mon11	0.1226	0.0083	14.7426	0.0000
mon12	0.0719	0.0084	8.5806	0.0000

Table 4: 202210 Summary of Sunspot Numbers

year	mon	day	obs	sidc
Min. :2008	Min. : 1.000	Min. : 0.00	Length:161964	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 : 6.586	Mean :15.71		Mean :0.2456
3rd Qu.:2020	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: 202210 Summary of Sunspot Numbers

g	s	w	see	method
Min. : 0.000	Min. : 0.00	Min. : 0.00	Length:161964	Length:161964
1st Qu.: 0.000	1st Qu.: 0.00	1st Qu.: 0.00	Class :character	Class :character
Median : 2.000	Median : 8.00	Median : 31.00	Mode :character	Mode :character
Mean : 2.791	Mean : 16.17	Mean : 44.08		
3rd Qu.: 5.000	3rd Qu.: 24.00	3rd Qu.: 70.00		
Max. :19.000	Max. :204.00	Max. :335.00		

Table 6: 202210 Summary of Sunspot Numbers

inst	filter	unit
Length:161964	Length:161964	Length:161964
Class :character	Class :character	Class :character
Mode :character	Mode :character	Mode :character

Table 7: 202210 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 : 92.35	Mean : 36.57	Mean : 890.6	Mean : 180.3
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

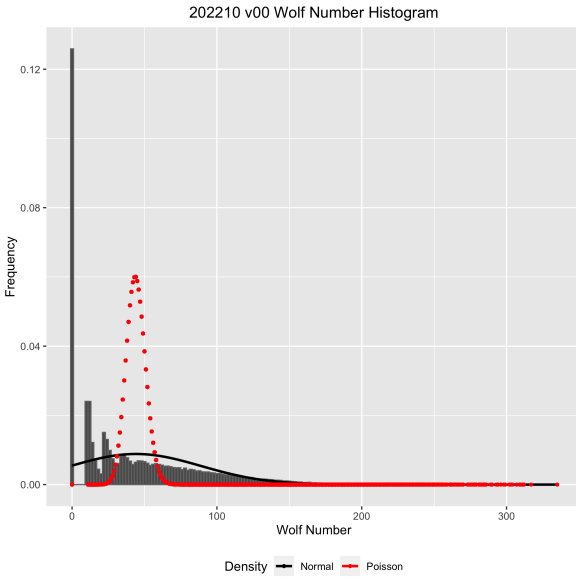


Figure 3: Box plots of raw Wolf number ( $w$ ) by observer rank.

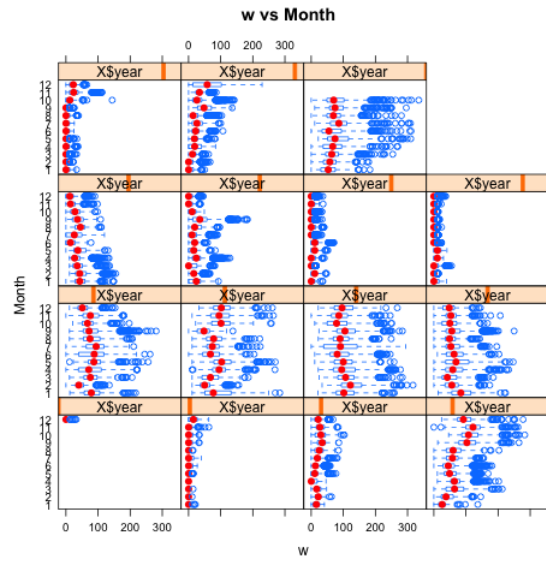


Figure 4: Box plots of raw Wolf number ( $w$ ) by month and year.

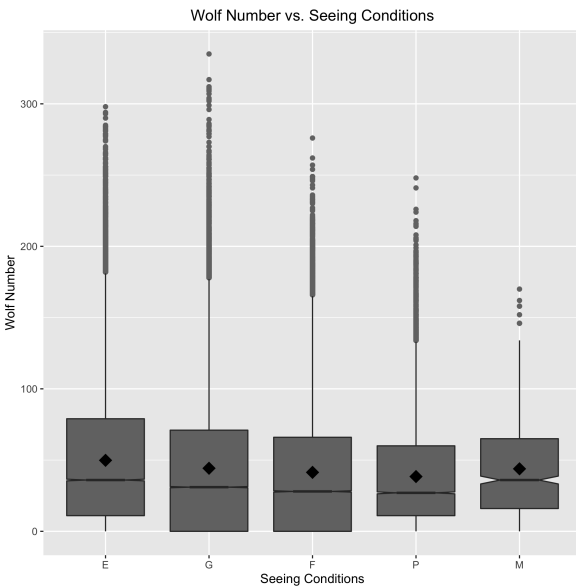


Figure 5: Box plots of raw Wolf number ( $w$ ) by seeing condition.

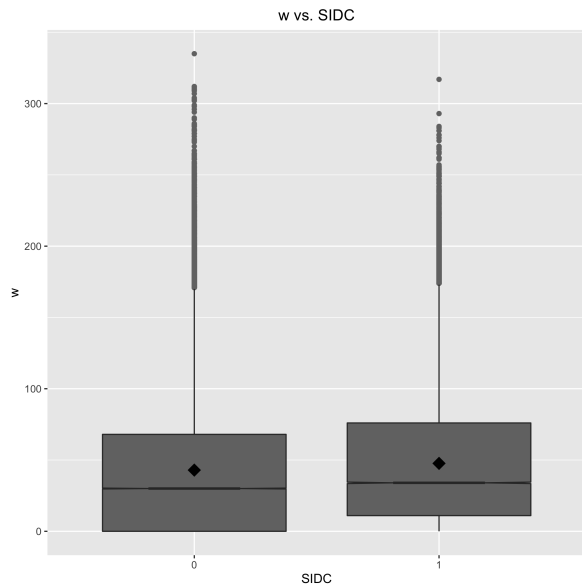


Figure 6: Box plots of raw Wolf number ( $w$ ) by organization.

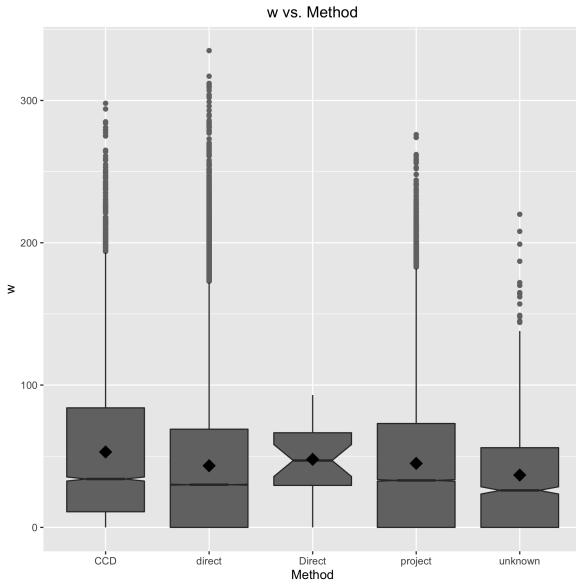


Figure 7: Box plots of raw Wolf number (w) by observer rank.

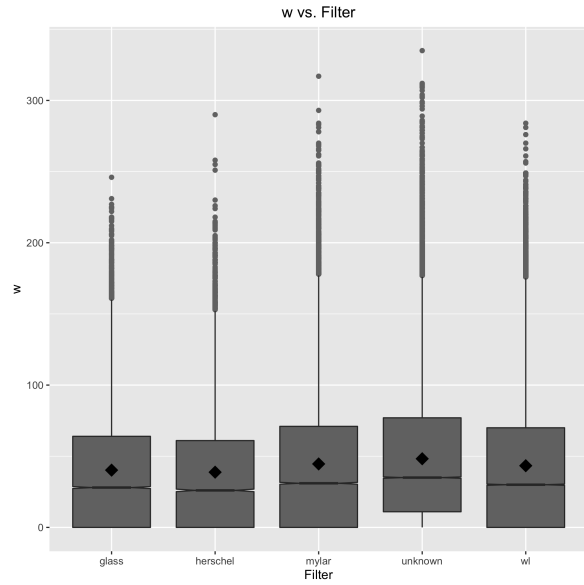


Figure 8: Box plots of raw Wolf number (w) by month and year.

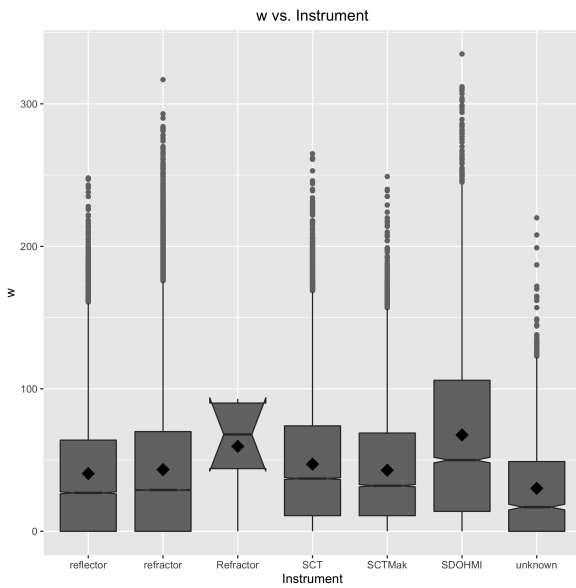


Figure 9: Box plots of raw Wolf number (w) by seeing condition.

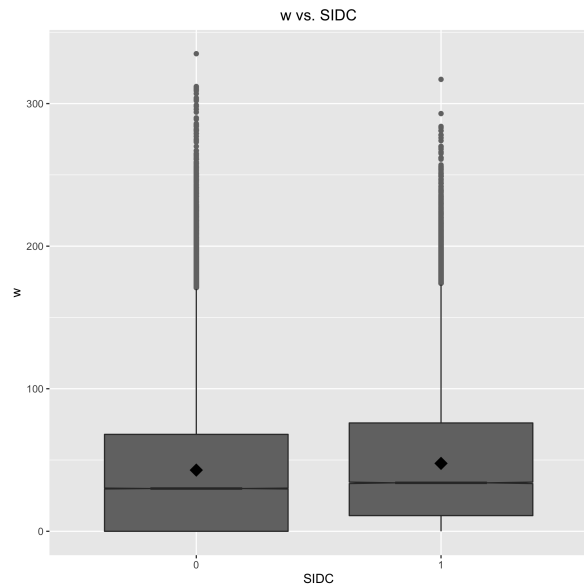


Figure 10: Box plots of raw Wolf number (w) by organization.



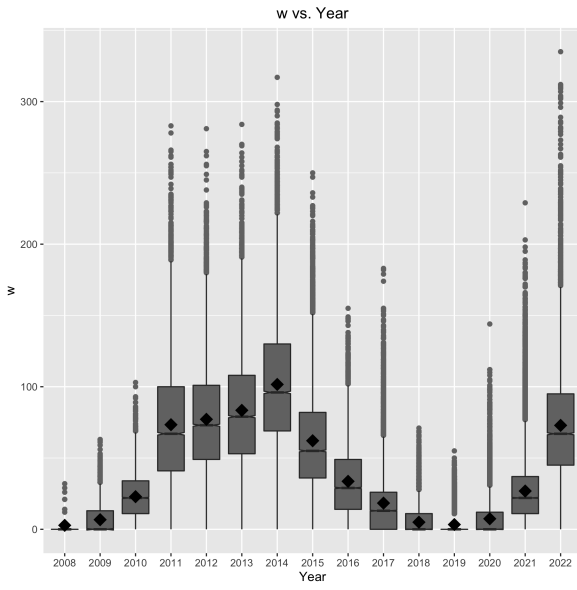


Figure 11: Box plots of raw Wolf number ( $w$ ) by year.

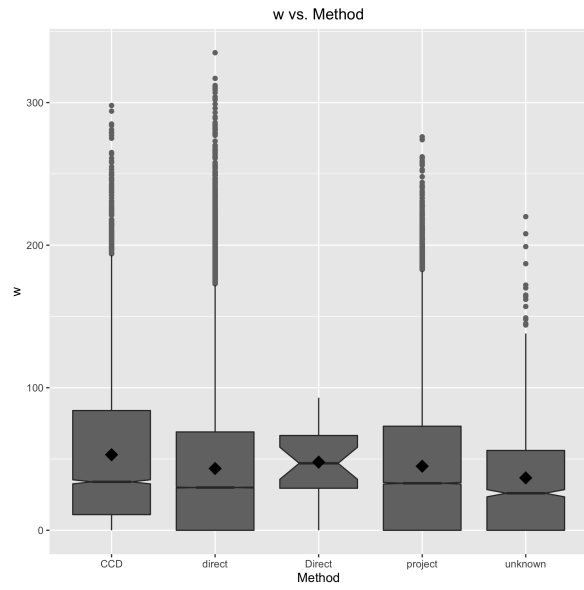


Figure 12: Box plots of raw Wolf number ( $w$ ) by observing method.