Monthly Report (00)

202211 Data Set

Wednesday 14th December, 2022

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.

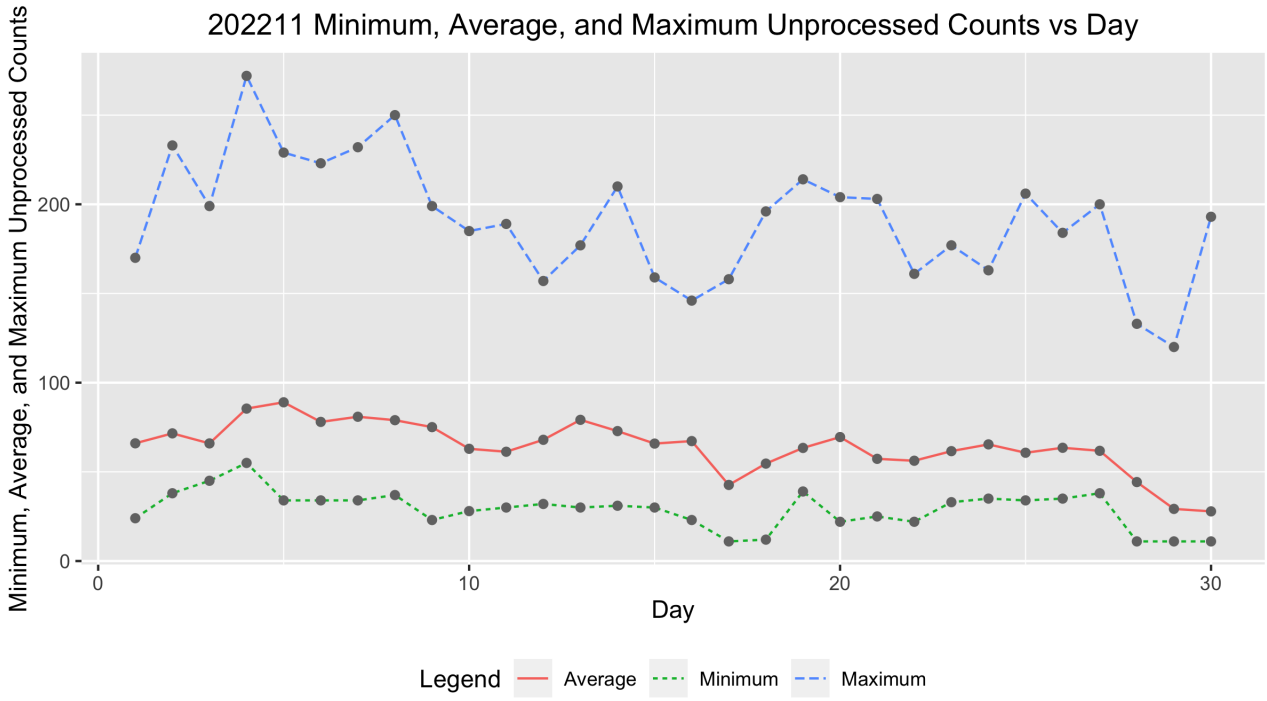

Figure 1: Raw average sunspot count by day of the month.

Table 1: 202211 Daily Raw Counts

Day	Submissions	Minimum	Average	Maximum
1.0000	33.0000	24.0000	66.0000	170.0000
2.0000	40.0000	38.0000	71.5750	233.0000
3.0000	38.0000	45.0000	65.9474	199.0000
4.0000	41.0000	55.0000	85.4634	272.0000
5.0000	39.0000	34.0000	89.0000	229.0000
6.0000	36.0000	34.0000	78.0000	223.0000
7.0000	39.0000	34.0000	80.8974	232.0000
8.0000	38.0000	37.0000	78.9737	250.0000
9.0000	39.0000	23.0000	75.0769	199.0000
10.0000	39.0000	28.0000	62.9231	185.0000
11.0000	33.0000	30.0000	61.2727	189.0000
12.0000	29.0000	32.0000	67.9655	157.0000
13.0000	37.0000	30.0000	79.1622	177.0000
14.0000	26.0000	31.0000	72.8462	210.0000
15.0000	26.0000	30.0000	65.8462	159.0000
16.0000	32.0000	23.0000	67.2500	146.0000
17.0000	32.0000	11.0000	42.6562	158.0000
18.0000	35.0000	12.0000	54.6286	196.0000
19.0000	36.0000	39.0000	63.4167	214.0000
20.0000	38.0000	22.0000	69.5000	204.0000
21.0000	30.0000	25.0000	57.3000	203.0000
22.0000	35.0000	22.0000	56.2286	161.0000
23.0000	36.0000	33.0000	61.6111	177.0000
24.0000	35.0000	35.0000	65.4000	163.0000
25.0000	34.0000	34.0000	60.7059	206.0000
26.0000	36.0000	35.0000	63.5000	184.0000
27.0000	34.0000	38.0000	61.7941	200.0000
28.0000	29.0000	11.0000	44.2759	133.0000
29.0000	22.0000	11.0000	29.2273	120.0000
30.0000	26.0000	11.0000	27.8462	193.0000

3 Error Tables

Data are for the month of November 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^{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	5.2208	4.6792	5.7623	1.3000	1.3000
2009.02	4.6437	4.1481	5.1393	0.7000	1.2000
2009.03	6.1864	5.9568	6.4160	0.3000	0.6000
2009.04	6.9855	6.7501	7.2209	0.4000	1.2000
2009.05	7.1770	6.9072	7.4467	1.6000	2.9000
2009.06	6.4521	6.1387	6.7655	3.2000	6.3000
2009.07	6.4349	6.1836	6.6863	3.6000	5.5000
2009.08	6.7312	6.4848	6.9776	0.0000	0.0000
2009.09	7.4449	7.1939	7.6959	4.5000	7.1000
2009.10	6.9695	6.6142	7.3248	4.5000	7.7000
2009.11	6.9703	6.7788	7.1619	3.3000	6.9000
2009.12	7.0533	6.8515	7.2551	10.4000	16.3000
2010.01	19.6146	17.4787	21.7506	13.3000	19.5000
2010.02	15.8069	13.7558	17.8580	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	17.8475	15.7260	19.9689	15.4000	24.0000
2010.04	19.8224	17.5849	22.0598	7.0000	10.4000
2010.05	23.6904	23.2660	24.1149	8.4000	8.7000
2010.06	20.0195	19.6743	20.3647	11.0000	13.6000
2010.07	21.8497	21.5171	22.1824	15.2000	16.1000
2010.08	22.0384	21.6587	22.4180	18.3000	19.6000
2010.09	25.3980	24.9621	25.8338	22.8000	25.2000
2010.10	24.1107	23.6735	24.5478	21.0000	23.5000
2010.11	24.5529	24.0983	25.0075	20.9000	21.6000
2010.12	23.9555	23.4685	24.4424	13.9000	14.5000
2011.01	70.2542	68.8065	71.7020	17.7000	18.7000
2011.02	61.5846	60.2690	62.9001	29.1000	29.6000
2011.03	67.3102	66.0007	68.6197	48.0000	55.8000
2011.04	75.9570	74.5145	77.3995	47.3000	54.4000
2011.05	77.9839	76.6252	79.3425	37.3000	41.5000
2011.06	65.7649	64.5855	66.9442	35.2000	37.0000
2011.07	70.8499	69.6233	72.0765	41.5000	43.8000
2011.08	72.2514	71.0676	73.4352	42.4000	50.5000
2011.09	82.1067	80.6482	83.5652	73.8000	78.0000
2011.10	77.9105	76.5688	79.2522	78.9000	88.0000
2011.11	79.2616	77.6139	80.9092	84.6000	96.7000
2011.12	75.8206	74.2633	77.3779	65.8000	73.0000
2012.01	75.4949	73.9935	76.9962	55.8000	58.2000
2012.02	65.0865	63.7410	66.4319	29.2000	33.1000
2012.03	71.8079	70.5227	73.0931	53.1000	64.1000
2012.04	79.5249	78.0839	80.9659	51.4000	55.2000
2012.05	83.4587	82.0429	84.8746	61.8000	69.0000
2012.06	69.8104	68.6047	71.0160	59.7000	64.5000
2012.07	75.8208	74.5513	77.0902	64.2000	51.3000
2012.08	74.4296	73.2001	75.6590	57.7000	63.1000
2012.09	85.0247	83.5273	86.5221	57.7000	61.5000
2012.10	81.5272	80.0114	83.0429	48.3000	53.3000
2012.11	83.1734	81.4847	84.8620	56.7000	61.4000
2012.12	79.5899	77.8505	81.3294	37.4000	40.8000
2013.01	83.7796	82.1575	85.4018	63.8000	62.9000
2013.02	72.3567	70.8781	73.8352	37.8000	38.0000
2013.03	77.3631	75.7655	78.9607	50.6000	57.9000
2013.04	86.7216	85.1613	88.2819	70.6000	72.4000
2013.05	88.8781	87.2521	90.5040	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	75.8693	74.4908	77.2478	51.0000	52.5000
2013.07	81.3950	80.0455	82.7445	57.0000	57.0000
2013.08	81.6414	80.2911	82.9917	60.0000	66.0000
2013.09	91.7018	90.0330	93.3706	34.6000	36.9000
2013.10	86.8893	85.2483	88.5303	74.5000	85.6000
2013.11	87.1707	85.1706	89.1707	73.9000	77.6000
2013.12	85.7234	83.8750	87.5717	77.8000	90.3000
2014.01	97.8187	95.7357	99.9016	77.4000	82.0000
2014.02	86.2759	84.5353	88.0164	93.9000	102.8000
2014.03	94.3088	92.5586	96.0590	80.9000	92.2000
2014.04	105.8665	103.9684	107.7646	76.9000	84.7000
2014.05	109.1243	107.2282	111.0205	72.3000	75.2000
2014.06	93.0177	91.4058	94.6296	67.2000	71.0000
2014.07	99.4146	97.7119	101.1173	72.5000	72.5000
2014.08	99.7973	98.2063	101.3882	71.2000	74.7000
2014.09	113.3971	111.3537	115.4404	83.2000	87.6000
2014.10	106.9352	104.9381	108.9323	59.5000	60.6000
2014.11	108.3855	106.0933	110.6778	65.8000	71.1000
2014.12	104.1033	101.6829	106.5236	75.8000	78.0000
2015.01	60.4495	59.2330	61.6661	65.9000	67.0000
2015.02	52.1176	50.9431	53.2921	42.4000	44.8000
2015.03	57.7373	56.6642	58.8103	38.0000	38.4000
2015.04	64.4706	63.2913	65.6498	49.0000	54.4000
2015.05	66.5597	65.4388	67.6806	56.3000	58.8000
2015.06	56.4821	55.4644	57.4998	50.2000	68.3000
2015.07	59.7714	58.7584	60.7843	47.9000	65.8000
2015.08	61.1763	60.1541	62.1984	39.5000	57.2000
2015.09	68.7773	67.5301	70.0245	49.2000	72.1000
2015.10	65.2960	64.0372	66.5548	39.3000	48.3000
2015.11	66.7783	65.3208	68.2358	39.6000	55.9000
2015.12	64.5477	63.1137	65.9816	36.4000	44.8000
2016.01	33.0829	32.3924	33.7733	33.7000	43.3000
2016.02	28.5583	27.9619	29.1547	38.3000	46.8000
2016.03	31.1660	30.5427	31.7893	30.5000	38.9000
2016.04	34.6277	33.9662	35.2892	26.6000	30.9000
2016.05	35.8951	35.2395	36.5506	33.7000	48.4000
2016.06	30.1808	29.6656	30.6961	13.1000	19.5000
2016.07	32.5871	32.0646	33.1096	21.2000	27.5000
2016.08	32.9608	32.3815	33.5402	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	37.9186	37.2268	38.6103	27.7000	37.1000
2016.10	35.6884	35.0017	36.3751	22.7000	31.7000
2016.11	36.0938	35.3392	36.8485	14.0000	22.2000
2016.12	35.3274	34.5680	36.0868	11.1000	20.0000
2017.01	17.8814	17.5034	18.2594	18.4000	26.2000
2017.02	15.4975	15.1559	15.8390	14.4000	20.6000
2017.03	17.0453	16.7196	17.3710	11.3000	15.5000
2017.04	19.1255	18.7876	19.4633	21.6000	33.2000
2017.05	19.5510	19.2126	19.8893	12.5000	18.1000
2017.06	16.3988	16.1263	16.6713	15.5000	19.3000
2017.07	17.7796	17.4949	18.0644	11.5000	16.3000
2017.08	17.9442	17.6312	18.2572	22.8000	35.7000
2017.09	20.9753	20.5384	21.4122	34.6000	42.9000
2017.10	19.2208	18.8260	19.6157	10.5000	11.0000
2017.11	19.3200	18.9100	19.7299	4.2000	5.6000
2017.12	18.8088	18.5216	19.0960	4.0000	4.6000
2018.01	4.9845	4.8779	5.0910	3.1000	6.3000
2018.02	4.2765	4.1728	4.3803	6.8000	11.8000
2018.03	4.6274	4.5339	4.7210	1.1000	1.2000
2018.04	5.1358	5.0328	5.2388	4.7000	7.5000
2018.05	5.3263	5.2269	5.4256	8.4000	14.0000
2018.06	4.4885	4.4096	4.5674	10.2000	13.6000
2018.07	4.8707	4.8159	4.9255	0.5000	1.7000
2018.08	4.8626	4.7796	4.9456	5.9000	9.5000
2018.09	5.4755	5.3732	5.5778	1.6000	2.9000
2018.10	5.2856	5.1820	5.3892	2.5000	5.6000
2018.11	5.3280	5.2166	5.4394	3.1000	4.2000
2018.12	5.2873	5.1842	5.3904	1.6000	2.3000
2019.01	3.2972	3.2343	3.3601	5.4000	2.3000
2019.02	2.8909	2.8342	2.9477	0.1000	1.2000
2019.03	3.0934	3.0410	3.1459	6.1000	12.1000
2019.04	3.4695	3.4045	3.5346	6.2000	9.3000
2019.05	3.4871	3.4266	3.5476	7.0000	11.9000
2019.06	2.9511	2.9015	3.0006	0.7000	1.5000
2019.07	3.1975	3.1503	3.2448	0.4000	2.2000
2019.08	3.2430	3.1951	3.2909	0.3000	0.8000
2019.09	3.7321	3.6738	3.7904	0.5000	1.0000
2019.10	3.4953	3.4359	3.5547	0.2000	0.5000
2019.11	3.5999	3.5309	3.6689	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	3.4781	3.4094	3.5469	0.8000	1.0000
2020.01	7.2997	7.1569	7.4425	4.0000	5.3000
2020.02	6.3321	6.2051	6.4592	0.1000	0.0000
2020.03	6.8388	6.7110	6.9665	1.2000	1.5000
2020.04	7.7176	7.5910	7.8441	3.0000	5.1000
2020.05	7.8243	7.7024	7.9462	0.1000	0.4000
2020.06	6.6617	6.5601	6.7633	3.9000	6.4000
2020.07	7.1133	7.0094	7.2172	4.2000	7.7000
2020.08	7.1060	7.0076	7.2044	5.3000	7.8000
2020.09	8.1509	8.0206	8.2813	0.4000	0.9000
2020.10	7.8174	7.6887	7.9461	9.9000	13.6000
2020.11	7.9766	7.8477	8.1056	21.2000	33.1000
2020.12	7.7353	7.5965	7.8740	15.4000	19.8000
2021.01	25.5582	25.1013	26.0152	7.0000	15.8000
2021.02	22.5190	22.1163	22.9218	5.8000	10.7000
2021.03	24.4932	24.1034	24.8830	11.0000	17.2000
2021.04	27.6718	27.2293	28.1143	18.5000	28.8000
2021.05	28.3720	27.9553	28.7888	15.9000	22.9000
2021.06	24.0045	23.6442	24.3647	19.9000	24.1000
2021.07	25.5820	25.1754	25.9887	23.8000	35.6000
2021.08	26.4109	25.9922	26.8296	15.7000	19.5000
2021.09	29.9652	29.4760	30.4544	39.1000	52.5000
2021.10	29.0574	28.5640	29.5509	27.1000	37.0000
2021.11	29.4057	28.9166	29.8949	27.2000	35.1000
2021.12	29.2724	28.7285	29.8163	50.6000	69.0000
2022.01	70.6245	69.4284	71.8207	43.9000	62.0000
2022.02	62.1070	61.0183	63.1957	48.8000	60.5000
2022.03	68.1596	66.9796	69.3396	58.4000	80.6000
2022.04	74.1777	73.0403	75.3150	59.1000	83.9000
2022.05	78.7377	77.5051	79.9703	72.5000	0.4000
2022.06	64.8656	63.8642	65.8671	58.9000	0.4000
2022.07	70.9196	69.7888	72.0504	76.7000	102.5000
2022.08	71.5189	70.3908	72.6471	63.3000	86.0000
2022.09	80.7396	79.3042	82.1749	72.6000	94.5000
2022.10	76.7499	75.4531	78.0468	66.4000	112.1000
2022.11	77.3184	75.9021	78.7348	54.3000	82.1000

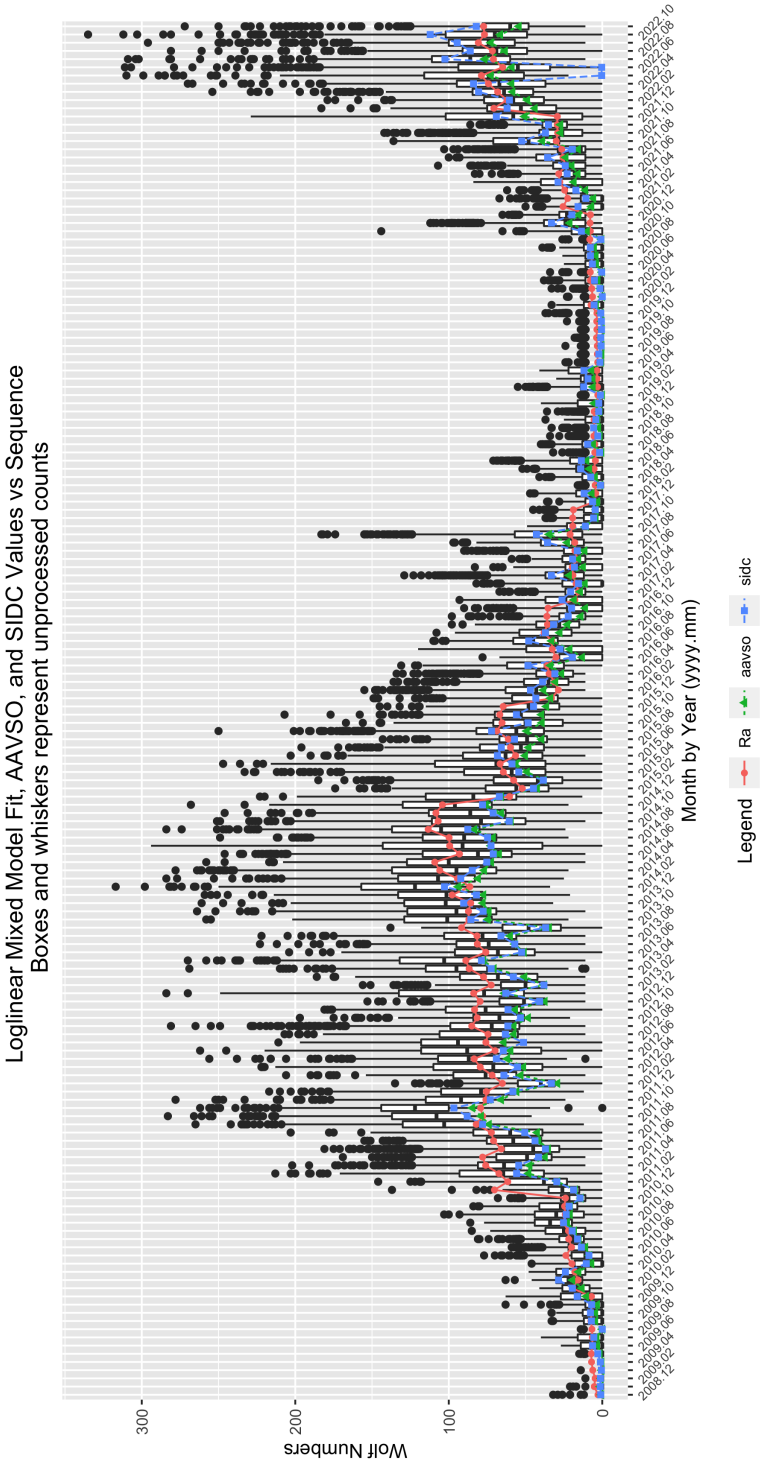

Figure 2: GLMM fitted data for R_a. AAVSO data: https://www.aavso.org/category/tags/solar-bulletin. SILSO data: WDC-SILSO, Royal Observatory of Belgium, Brussels

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: 202211 Parameter Estimates

	Estimate	Std. Error	t-value	Pr(>|t|)
(Intercept)	1.2482	0.3154	3.9578	0.0001
seeF	-0.2265	0.0053	-42.3334	0.0000
seeG	-0.1195	0.0047	-25.6050	0.0000
seeM	-0.1892	0.0243	-7.7706	0.0000
seeP	-0.3232	0.0077	-42.0155	0.0000
sidc1	0.0567	0.0135	4.2129	0.0000
year2009	0.7274	0.3168	2.2958	0.0217
year2010	1.9557	0.3146	6.2161	0.0000
year2011	3.0973	0.3145	9.8474	0.0000
year2012	3.1381	0.3145	9.9774	0.0000
year2013	3.2334	0.3145	10.2805	0.0000
year2014	3.4315	0.3145	10.9106	0.0000
year2015	2.9487	0.3145	9.3749	0.0000
year2016	2.3328	0.3146	7.4161	0.0000
year2017	1.7218	0.3146	5.4732	0.0000
year2018	0.4370	0.3149	1.3876	0.1652
year2019	0.0200	0.3151	0.0635	0.9494
year2020	0.8260	0.3148	2.6242	0.0087
year2021	2.1075	0.3146	6.6995	0.0000
year2022	3.0678	0.3146	9.7527	0.0000
mon2	-0.1380	0.0086	-16.0802	0.0000
mon3	-0.0553	0.0080	-6.8861	0.0000
mon4	0.0483	0.0077	6.2533	0.0000
mon5	0.0724	0.0076	9.5628	0.0000
mon6	-0.0978	0.0079	-12.3981	0.0000
mon7	-0.0302	0.0076	-3.9462	0.0001
mon8	-0.0185	0.0076	-2.4414	0.0146
mon9	0.1186	0.0076	15.6669	0.0000
mon10	0.0676	0.0077	8.7508	0.0000
mon11	0.0945	0.0080	11.7944	0.0000
mon12	0.0693	0.0084	8.2890	0.0000

Table 4: 202211 Summary of Sunspot Numbers

year	mon	day	obs	sidc
Min. :2008	Min. : 1.000	Min. : 0.00	Length:162987	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 : 6.613	Mean :15.71		Mean :0.2452
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: 202211 Summary of Sunspot Numbers

g	s	w	see	method
Min. : 0.000	Min. : 0.00	Min. : 0.00	Length:162987	Length:162987
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 : 2.803	Mean : 16.19	Mean : 44.22		
3rd Qu.: 5.000	3rd Qu.: 24.00	3rd Qu.: 70.00		
Max. :21.000	Max. :204.00	Max. :335.00		

Table 6: 202211 Summary of Sunspot Numbers

inst	filter	unit
Length:162987	Length:162987	Length:162987
Class :character	Class :character	Class :character
Mode :character	Mode :character	Mode :character

Table 7: 202211 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 : 92.45	Mean : 36.77	Mean : 890.9	Mean : 180.2
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

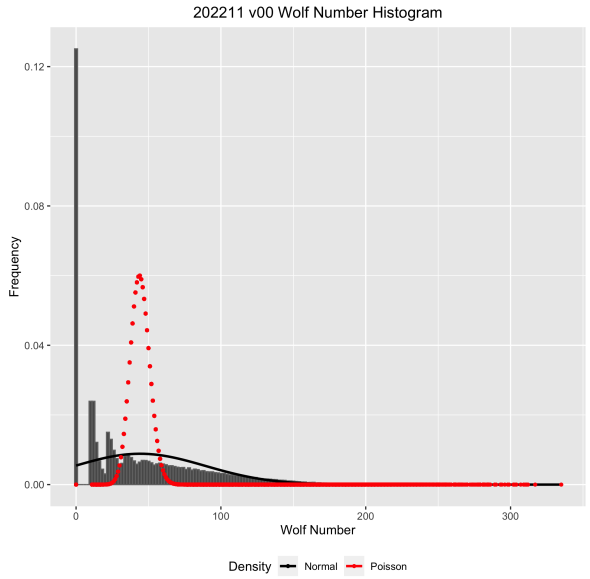

Figure 3: Box plots of raw Wolf number (w) by observer rank.

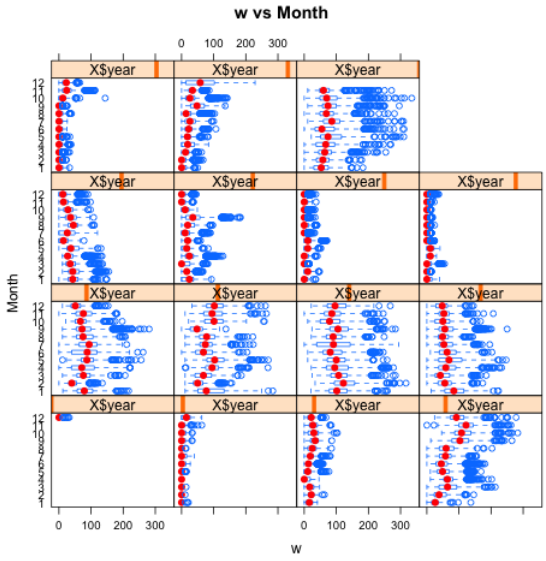

Figure 4: Box plots of raw Wolf number (w) by month and year.

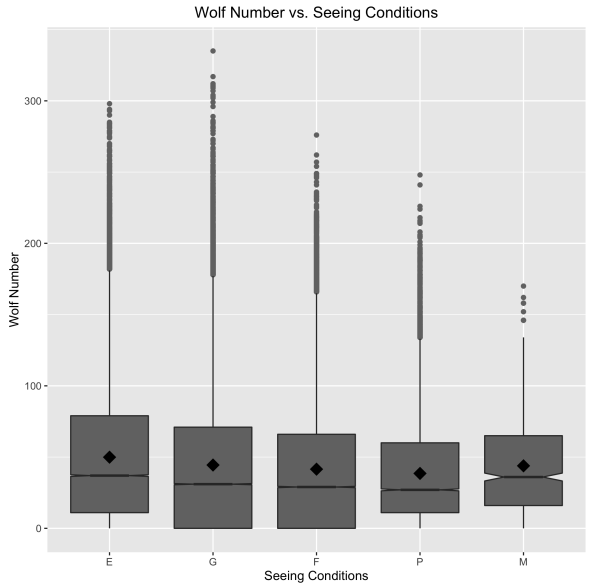

Figure 5: Box plots of raw Wolf number (w) by seeing condition.

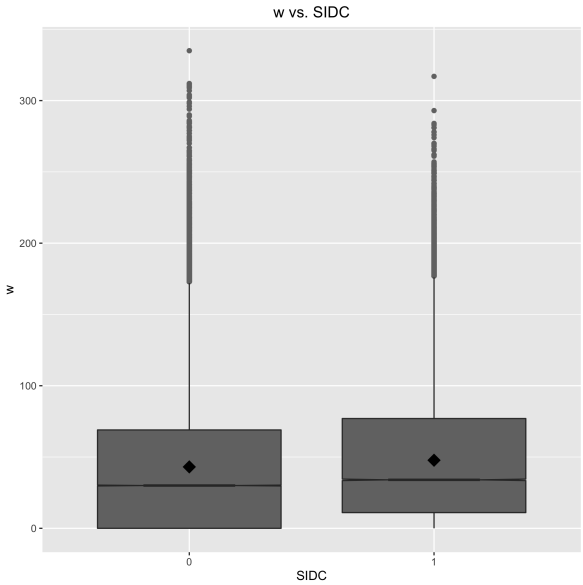

Figure 6: Box plots of raw Wolf number (w) by organization.

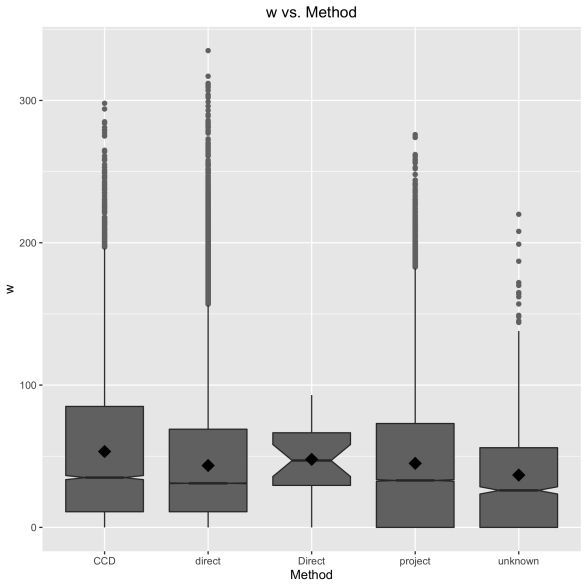

Figure 7: Box plots of raw Wolf number (w) by observer rank.

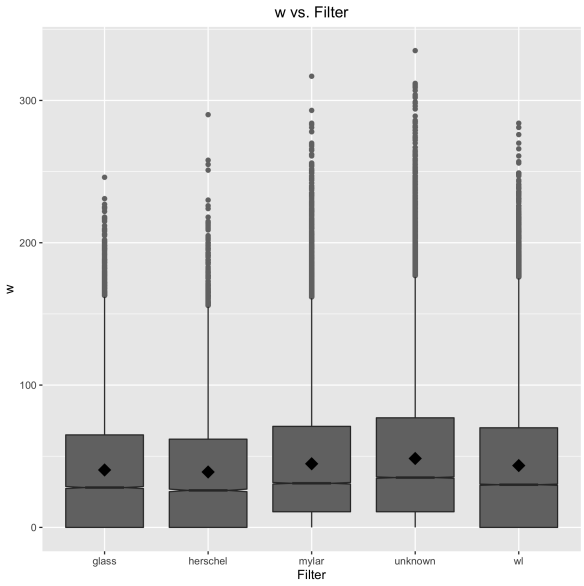

Figure 8: Box plots of raw Wolf number (w) by month and year.

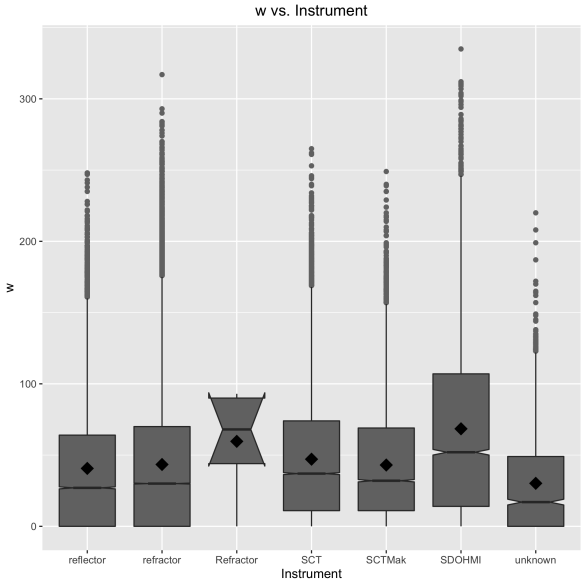

Figure 9: Box plots of raw Wolf number (w) by seeing condition.

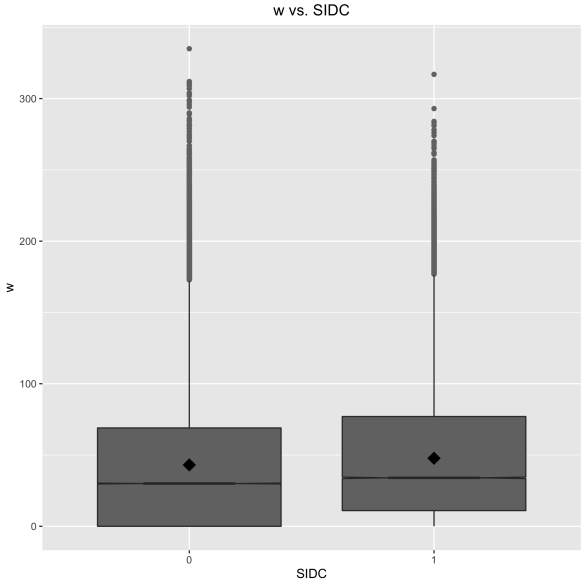

Figure 10: Box plots of raw Wolf number (w) by organization.

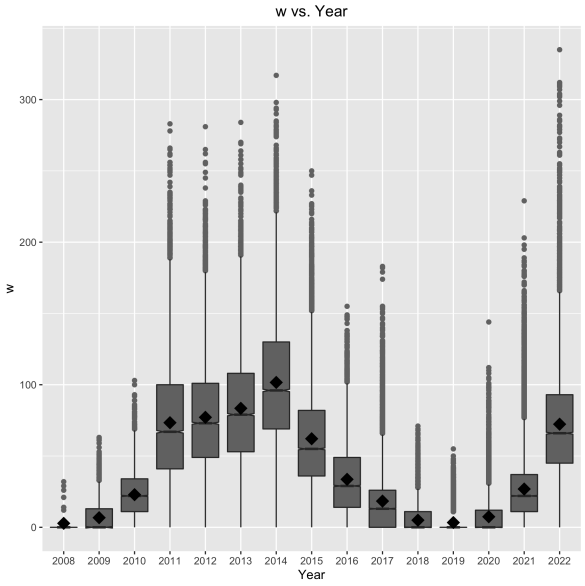

Figure 11: Box plots of raw Wolf number (w) by year.

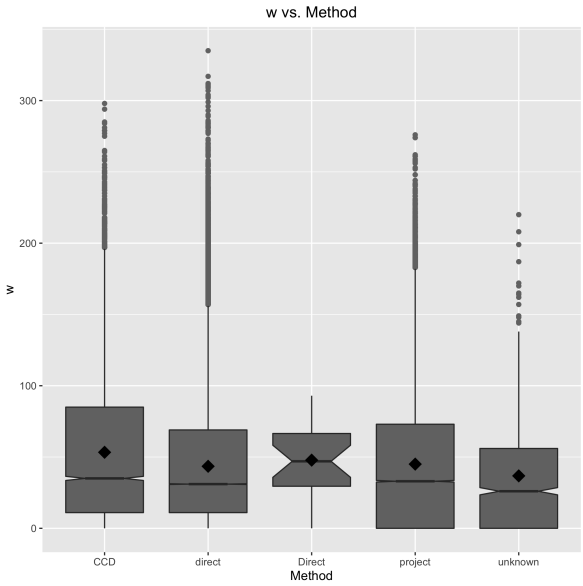

Figure 12: Box plots of raw Wolf number (w) by observing method.