Monthly Report (00)

2022.09 Data Set

Saturday 15th October, 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.

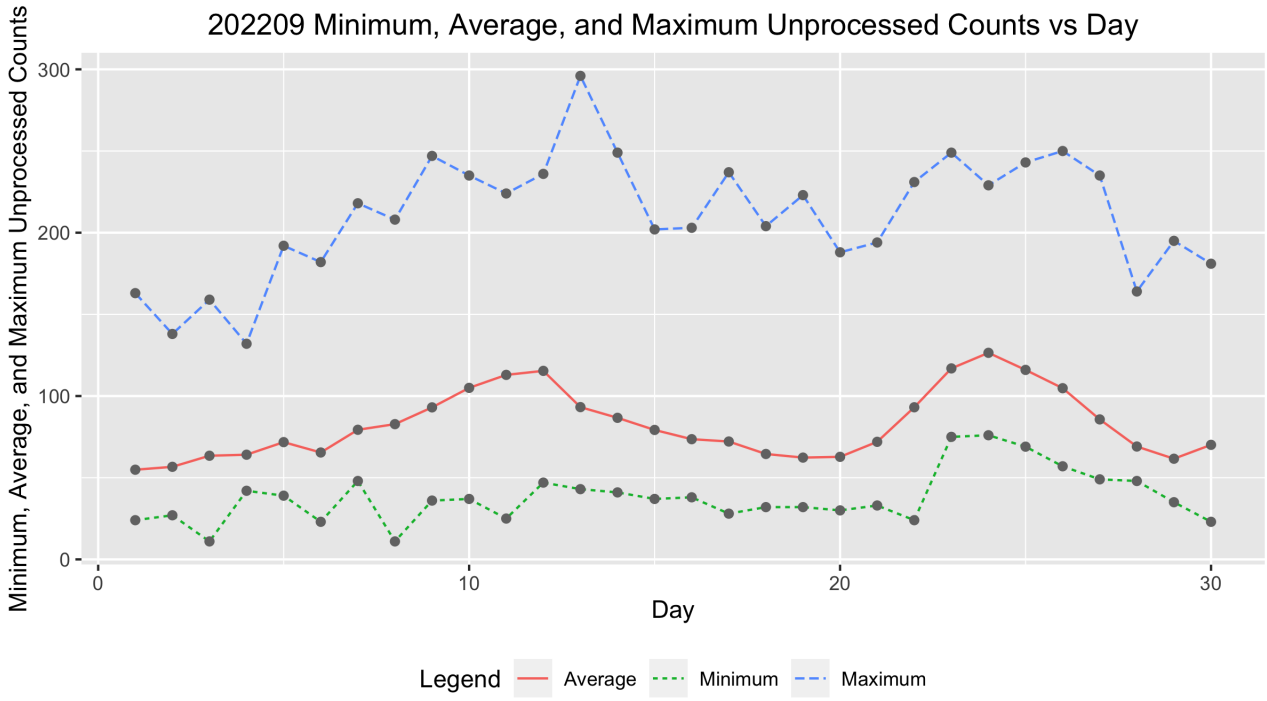

Figure 1: Raw average sunspot count by day of the month.

Table 1: 202209 Daily Raw Counts

Day	Submissions	Minimum	Average	Maximum
1.0000	38.0000	24.0000	54.8947	163.0000
2.0000	36.0000	27.0000	56.6667	138.0000
3.0000	35.0000	11.0000	63.4571	159.0000
4.0000	37.0000	42.0000	64.0811	132.0000
5.0000	33.0000	39.0000	71.7879	192.0000
6.0000	39.0000	23.0000	65.4359	182.0000
7.0000	35.0000	48.0000	79.3429	218.0000
8.0000	34.0000	11.0000	82.7941	208.0000
9.0000	35.0000	36.0000	93.0571	247.0000
10.0000	36.0000	37.0000	105.0000	235.0000
11.0000	40.0000	25.0000	112.9500	224.0000
12.0000	39.0000	47.0000	115.4103	236.0000
13.0000	28.0000	43.0000	93.2143	296.0000
14.0000	30.0000	41.0000	86.6667	249.0000
15.0000	37.0000	37.0000	79.2432	202.0000
16.0000	41.0000	38.0000	73.5854	203.0000
17.0000	43.0000	28.0000	72.1628	237.0000
18.0000	38.0000	32.0000	64.5263	204.0000
19.0000	32.0000	32.0000	62.3125	223.0000
20.0000	37.0000	30.0000	62.7838	188.0000
21.0000	37.0000	33.0000	71.9730	194.0000
22.0000	35.0000	24.0000	93.1143	231.0000
23.0000	35.0000	75.0000	116.9143	249.0000
24.0000	33.0000	76.0000	126.4545	229.0000
25.0000	35.0000	69.0000	116.0000	243.0000
26.0000	36.0000	57.0000	104.8056	250.0000
27.0000	39.0000	49.0000	85.6923	235.0000
28.0000	33.0000	48.0000	69.0909	164.0000
29.0000	37.0000	35.0000	61.6216	195.0000
30.0000	34.0000	23.0000	70.1176	181.0000

3 Error Tables

Data are for the month of September 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	2.4232	3.1178	0.5000	1.0000
2009.01	5.1746	4.6381	5.7112	1.3000	1.3000
2009.02	4.6033	4.1122	5.0943	0.7000	1.2000
2009.03	6.1360	5.9088	6.3631	0.3000	0.6000
2009.04	6.9224	6.6892	7.1555	0.4000	1.2000
2009.05	7.1159	6.8494	7.3823	1.6000	2.9000
2009.06	6.3908	6.0807	6.7009	3.2000	6.3000
2009.07	6.3795	6.1311	6.6279	3.6000	5.5000
2009.08	6.6693	6.4256	6.9129	0.0000	0.0000
2009.09	7.3829	7.1342	7.6315	4.5000	7.1000
2009.10	6.8729	6.5235	7.2224	4.5000	7.7000
2009.11	7.0973	6.9035	7.2912	3.3000	6.9000
2009.12	6.9996	6.8010	7.1982	10.4000	16.3000
2010.01	19.5512	17.4216	21.6809	13.3000	19.5000
2010.02	15.7662	13.7199	17.8126	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	17.7890	15.6756	19.9024	15.4000	24.0000
2010.04	19.7529	17.5243	21.9816	7.0000	10.4000
2010.05	23.6416	23.2216	24.0616	8.4000	8.7000
2010.06	19.9623	19.6220	20.3026	11.0000	13.6000
2010.07	21.8025	21.4757	22.1292	15.2000	16.1000
2010.08	21.9912	21.6184	22.3640	18.3000	19.6000
2010.09	25.3418	24.9137	25.7698	22.8000	25.2000
2010.10	23.9131	23.4872	24.3390	21.0000	23.5000
2010.11	25.1745	24.7128	25.6362	20.9000	21.6000
2010.12	23.9280	23.4461	24.4100	13.9000	14.5000
2011.01	70.1319	68.6983	71.5655	17.7000	18.7000
2011.02	61.4992	60.1982	62.8002	29.1000	29.6000
2011.03	67.2284	65.9329	68.5239	48.0000	55.8000
2011.04	75.7764	74.3591	77.1937	47.3000	54.4000
2011.05	77.8564	76.5166	79.1962	37.3000	41.5000
2011.06	65.6283	64.4631	66.7936	35.2000	37.0000
2011.07	70.7589	69.5432	71.9747	41.5000	43.8000
2011.08	72.1633	70.9911	73.3354	42.4000	50.5000
2011.09	81.9851	80.5426	83.4275	73.8000	78.0000
2011.10	77.3774	76.0574	78.6974	78.9000	88.0000
2011.11	81.3213	79.6371	83.0055	84.6000	96.7000
2011.12	75.8206	74.2687	77.3725	65.8000	73.0000
2012.01	75.3520	73.8628	76.8411	55.8000	58.2000
2012.02	64.9656	63.6318	66.2993	29.2000	33.1000
2012.03	71.6980	70.4224	72.9737	53.1000	64.1000
2012.04	79.3725	77.9485	80.7965	51.4000	55.2000
2012.05	83.3292	81.9293	84.7292	61.8000	69.0000
2012.06	69.6509	68.4583	70.8434	59.7000	64.5000
2012.07	75.6939	74.4383	76.9494	64.2000	51.3000
2012.08	74.3399	73.1246	75.5552	57.7000	63.1000
2012.09	84.9126	83.4265	86.3988	57.7000	61.5000
2012.10	80.9525	79.4571	82.4479	48.3000	53.3000
2012.11	85.2881	83.5649	87.0113	56.7000	61.4000
2012.12	79.5898	77.8563	81.3232	37.4000	40.8000
2013.01	83.6383	82.0268	85.2498	63.8000	62.9000
2013.02	72.2555	70.7867	73.7243	37.8000	38.0000
2013.03	77.2755	75.6864	78.8647	50.6000	57.9000
2013.04	86.5601	85.0131	88.1072	70.6000	72.4000
2013.05	88.7635	87.1524	90.3745	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	75.7042	74.3407	77.0677	51.0000	52.5000
2013.07	81.2693	79.9340	82.6046	57.0000	57.0000
2013.08	81.5190	80.1808	82.8572	60.0000	66.0000
2013.09	91.5842	89.9271	93.2412	34.6000	36.9000
2013.10	86.2834	84.6626	87.9042	74.5000	85.6000
2013.11	89.3836	87.3445	91.4227	73.9000	77.6000
2013.12	85.7174	83.8748	87.5600	77.8000	90.3000
2014.01	97.6420	95.5705	99.7135	77.4000	82.0000
2014.02	86.1306	84.4041	87.8571	93.9000	102.8000
2014.03	94.1872	92.4482	95.9263	80.9000	92.2000
2014.04	105.6596	103.7782	107.5409	76.9000	84.7000
2014.05	108.9746	107.0926	110.8567	72.3000	75.2000
2014.06	92.8105	91.2146	94.4064	67.2000	71.0000
2014.07	99.2467	97.5597	100.9337	72.5000	72.5000
2014.08	99.6575	98.0796	101.2354	71.2000	74.7000
2014.09	113.2491	111.2217	115.2764	83.2000	87.6000
2014.10	106.2044	104.2305	108.1783	59.5000	60.6000
2014.11	111.1627	108.8253	113.5001	65.8000	71.1000
2014.12	104.1496	101.7317	106.5675	75.8000	78.0000
2015.01	60.3211	59.1100	61.5322	65.9000	67.0000
2015.02	52.0042	50.8397	53.1686	42.4000	44.8000
2015.03	57.6247	56.5593	58.6900	38.0000	38.4000
2015.04	64.2974	63.1301	65.4647	49.0000	54.4000
2015.05	66.4454	65.3330	67.5578	56.3000	58.8000
2015.06	56.3681	55.3549	57.3813	50.2000	68.3000
2015.07	59.7094	58.6985	60.7204	47.9000	65.8000
2015.08	61.1165	60.0964	62.1366	39.5000	57.2000
2015.09	68.6980	67.4535	69.9426	49.2000	72.1000
2015.10	64.8610	63.6112	66.1107	39.3000	48.3000
2015.11	68.5090	67.0156	70.0025	39.6000	55.9000
2015.12	64.5384	63.1060	65.9708	36.4000	44.8000
2016.01	33.0148	32.3269	33.7027	33.7000	43.3000
2016.02	28.5071	27.9125	29.1016	38.3000	46.8000
2016.03	31.1095	30.4882	31.7309	30.5000	38.9000
2016.04	34.5540	33.8948	35.2131	26.6000	30.9000
2016.05	35.8481	35.1942	36.5020	33.7000	48.4000
2016.06	30.1165	29.6032	30.6298	13.1000	19.5000
2016.07	32.5312	32.0102	33.0522	21.2000	27.5000
2016.08	32.9186	32.3409	33.4963	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	37.8674	37.1776	38.5572	27.7000	37.1000
2016.10	35.4384	34.7573	36.1195	22.7000	31.7000
2016.11	37.0101	36.2370	37.7832	14.0000	22.2000
2016.12	35.3084	34.5503	36.0665	11.1000	20.0000
2017.01	17.8414	17.4649	18.2179	18.4000	26.2000
2017.02	15.4703	15.1297	15.8108	14.4000	20.6000
2017.03	17.0184	16.6936	17.3431	11.3000	15.5000
2017.04	19.0855	18.7486	19.4223	21.6000	33.2000
2017.05	19.5202	19.1827	19.8577	12.5000	18.1000
2017.06	16.3620	16.0901	16.6339	15.5000	19.3000
2017.07	17.7495	17.4653	18.0337	11.5000	16.3000
2017.08	17.9188	17.6060	18.2315	22.8000	35.7000
2017.09	20.9507	20.5130	21.3883	34.6000	42.9000
2017.10	19.0918	18.6990	19.4846	10.5000	11.0000
2017.11	19.8117	19.3909	20.2325	4.2000	5.6000
2017.12	18.7919	18.5047	19.0792	4.0000	4.6000
2018.01	4.9767	4.8704	5.0830	3.1000	6.3000
2018.02	4.2713	4.1677	4.3749	6.8000	11.8000
2018.03	4.6215	4.5280	4.7150	1.1000	1.2000
2018.04	5.1253	5.0225	5.2281	4.7000	7.5000
2018.05	5.3188	5.2193	5.4182	8.4000	14.0000
2018.06	4.4791	4.4003	4.5579	10.2000	13.6000
2018.07	4.8626	4.8077	4.9174	0.5000	1.7000
2018.08	4.8559	4.7730	4.9388	5.9000	9.5000
2018.09	5.4684	5.3662	5.5706	1.6000	2.9000
2018.10	5.2511	5.1480	5.3542	2.5000	5.6000
2018.11	5.4658	5.3515	5.5801	3.1000	4.2000
2018.12	5.2863	5.1830	5.3895	1.6000	2.3000
2019.01	3.2892	3.2265	3.3518	5.4000	2.3000
2019.02	2.8866	2.8301	2.9431	0.1000	1.2000
2019.03	3.0876	3.0353	3.1399	6.1000	12.1000
2019.04	3.4628	3.3978	3.5277	6.2000	9.3000
2019.05	3.4817	3.4215	3.5420	7.0000	11.9000
2019.06	2.9452	2.8960	2.9945	0.7000	1.5000
2019.07	3.1920	3.1449	3.2391	0.4000	2.2000
2019.08	3.2382	3.1904	3.2860	0.3000	0.8000
2019.09	3.7286	3.6705	3.7867	0.5000	1.0000
2019.10	3.4711	3.4122	3.5300	0.2000	0.5000
2019.11	3.6916	3.6210	3.7622	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	3.4771	3.4085	3.5457	0.8000	1.0000
2020.01	7.2807	7.1384	7.4230	4.0000	5.3000
2020.02	6.3168	6.1902	6.4434	0.1000	0.0000
2020.03	6.8235	6.6962	6.9509	1.2000	1.5000
2020.04	7.6958	7.5696	7.8221	3.0000	5.1000
2020.05	7.8120	7.6901	7.9338	0.1000	0.4000
2020.06	6.6434	6.5422	6.7445	3.9000	6.4000
2020.07	7.0996	6.9960	7.2031	4.2000	7.7000
2020.08	7.0934	6.9956	7.1911	5.3000	7.8000
2020.09	8.1396	8.0100	8.2693	0.4000	0.9000
2020.10	7.7651	7.6379	7.8923	9.9000	13.6000
2020.11	8.1850	8.0539	8.3161	21.2000	33.1000
2020.12	7.7327	7.5948	7.8706	15.4000	19.8000
2021.01	25.4639	25.0114	25.9163	7.0000	15.8000
2021.02	22.4471	22.0466	22.8475	5.8000	10.7000
2021.03	24.4154	24.0273	24.8035	11.0000	17.2000
2021.04	27.5530	27.1205	27.9855	18.5000	28.8000
2021.05	28.2695	27.8614	28.6775	15.9000	22.9000
2021.06	23.9754	23.6235	24.3273	19.9000	24.1000
2021.07	25.5722	25.1749	25.9694	23.8000	35.6000
2021.08	26.3444	25.9348	26.7540	15.7000	19.5000
2021.09	29.9787	29.5023	30.4550	39.1000	52.5000
2021.10	28.8035	28.3225	29.2844	27.1000	37.0000
2021.11	30.2365	29.7485	30.7244	27.2000	35.1000
2021.12	29.3419	28.8133	29.8704	50.6000	69.0000
2022.01	71.3486	70.1579	72.5393	43.9000	62.0000
2022.02	62.7120	61.6289	63.7950	48.8000	60.5000
2022.03	68.8471	67.6737	70.0205	58.4000	80.6000
2022.04	75.1773	74.0517	76.3029	59.1000	83.9000
2022.05	79.5202	78.2951	80.7454	72.5000	0.4000
2022.06	65.6888	64.6973	66.6803	58.9000	0.4000
2022.07	71.6241	70.4978	72.7503	76.7000	102.5000
2022.08	72.1624	71.0400	73.2847	63.3000	86.0000
2022.09	81.4685	80.0455	82.8914	72.6000	94.5000

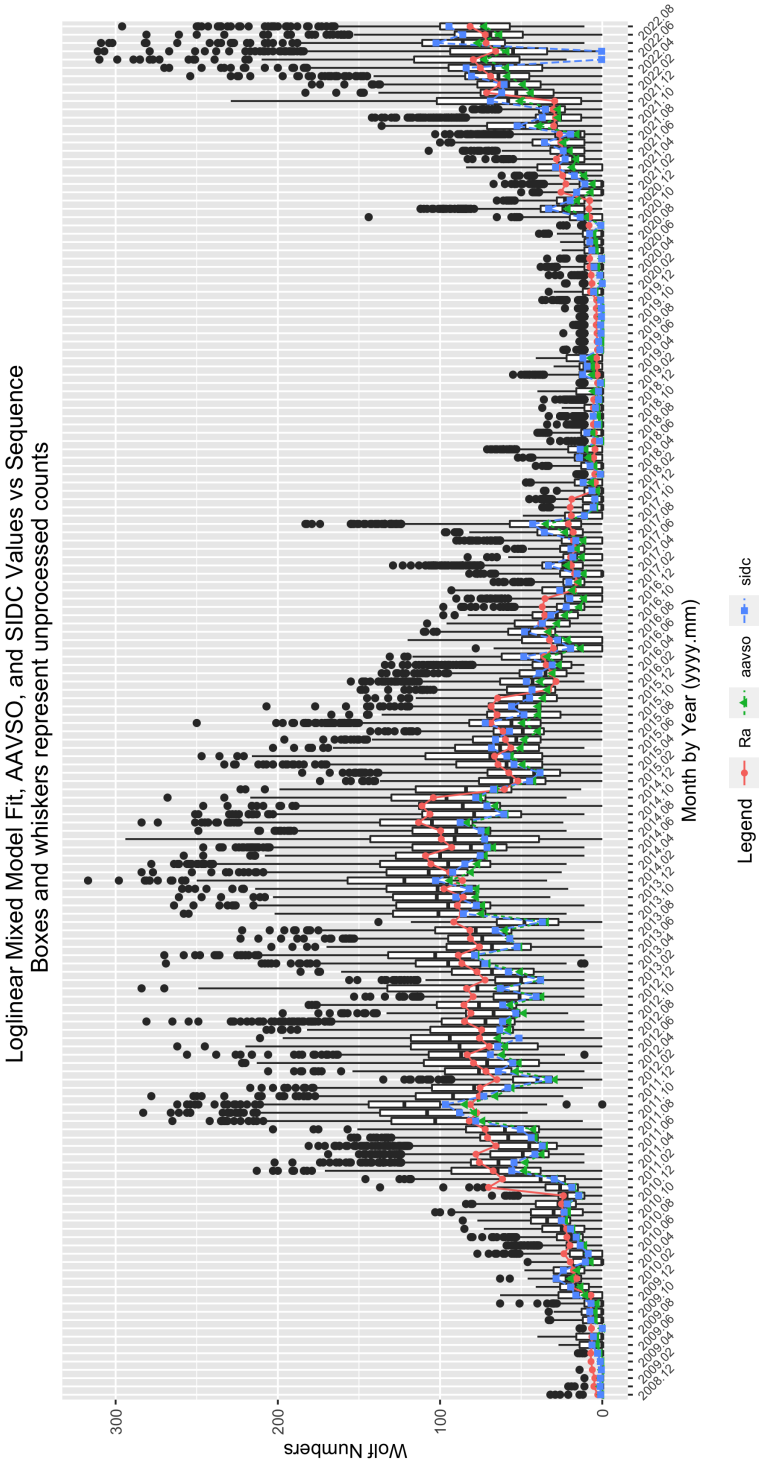

Figure 2: GLMM fitted data for R_a. AAVSO data: https://www.aavso.org/category/tags/solar-bulletin. SILSO data: WDC-SILSO, Royal Observatory of Belgium, Brussels

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: 202209 Parameter Estimates

	Estimate	Std. Error	t-value	Pr(>|t|)
(Intercept)	1.2498	0.3157	3.9591	0.0001
seeF	-0.2250	0.0054	-41.6257	0.0000
seeG	-0.1205	0.0047	-25.5446	0.0000
seeM	-0.1900	0.0244	-7.7938	0.0000
seeP	-0.3224	0.0078	-41.4685	0.0000
sidc1	0.0509	0.0141	3.6021	0.0003
year2009	0.7204	0.3171	2.2718	0.0231
year2010	1.9546	0.3149	6.2070	0.0000
year2011	3.0970	0.3148	9.8378	0.0000
year2012	3.1375	0.3148	9.9668	0.0000
year2013	3.2331	0.3148	10.2705	0.0000
year2014	3.4312	0.3148	10.8999	0.0000
year2015	2.9476	0.3148	9.3631	0.0000
year2016	2.3314	0.3148	7.4050	0.0000
year2017	1.7204	0.3149	5.4636	0.0000
year2018	0.4360	0.3152	1.3833	0.1666
year2019	0.0190	0.3154	0.0603	0.9519
year2020	0.8245	0.3150	2.6172	0.0089
year2021	2.1040	0.3149	6.6824	0.0000
year2022	3.0778	0.3148	9.7755	0.0000
mon2	-0.1375	0.0086	-16.0172	0.0000
mon3	-0.0547	0.0080	-6.8099	0.0000
mon4	0.0485	0.0077	6.2744	0.0000
mon5	0.0733	0.0076	9.6729	0.0000
mon6	-0.0976	0.0079	-12.3663	0.0000
mon7	-0.0294	0.0077	-3.8448	0.0001
mon8	-0.0175	0.0076	-2.3111	0.0208
mon9	0.1195	0.0076	15.7627	0.0000
mon10	0.0628	0.0081	7.7975	0.0000
mon11	0.1218	0.0083	14.6427	0.0000
mon12	0.0710	0.0084	8.4730	0.0000

Table 4: 202209 Summary of Sunspot Numbers

year	mon	day	obs	sidc
Min. :2008	Min. : 1.000	Min. : 0.00	Length:160802	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 : 6.561	Mean :15.71		Mean :0.2461
3rd Qu.:2019	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: 202209 Summary of Sunspot Numbers

g	s	w	see	method
Min. : 0.000	Min. : 0.00	Min. : 0.00	Length:160802	Length:160802
1st Qu.: 0.000	1st Qu.: 0.00	1st Qu.: 0.00	Class :character	Class :character
Median : 2.000	Median : 8.00	Median : 30.00	Mode :character	Mode :character
Mean : 2.777	Mean : 16.05	Mean : 43.82		
3rd Qu.: 4.000	3rd Qu.: 24.00	3rd Qu.: 70.00		
Max. :19.000	Max. :204.00	Max. :317.00		

Table 6: 202209 Summary of Sunspot Numbers

inst	filter	unit
Length:160802	Length:160802	Length:160802
Class :character	Class :character	Class :character
Mode :character	Mode :character	Mode :character

Table 7: 202209 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 : 92.24	Mean : 36.34	Mean : 890.3	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

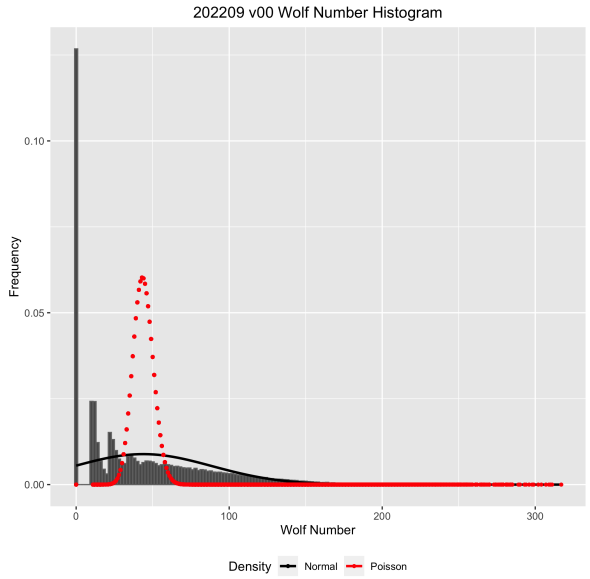

Figure 3: Box plots of raw Wolf number (w) by observer rank.

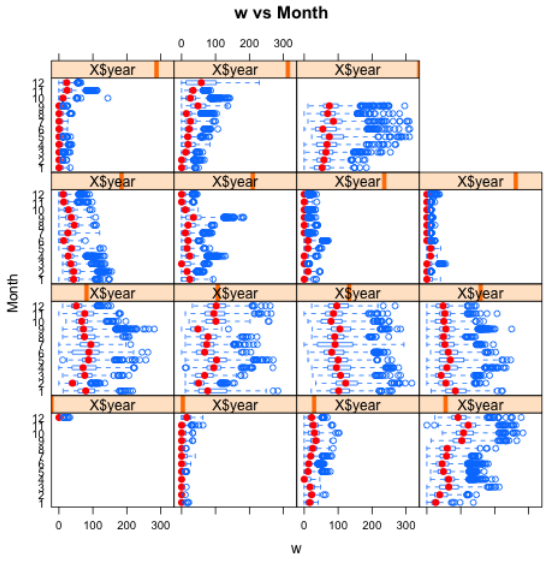

Figure 4: Box plots of raw Wolf number (w) by month and year.

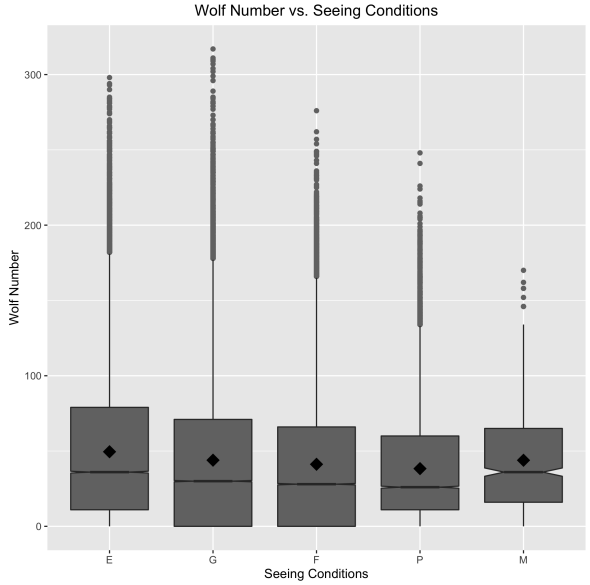

Figure 5: Box plots of raw Wolf number (w) by seeing condition.

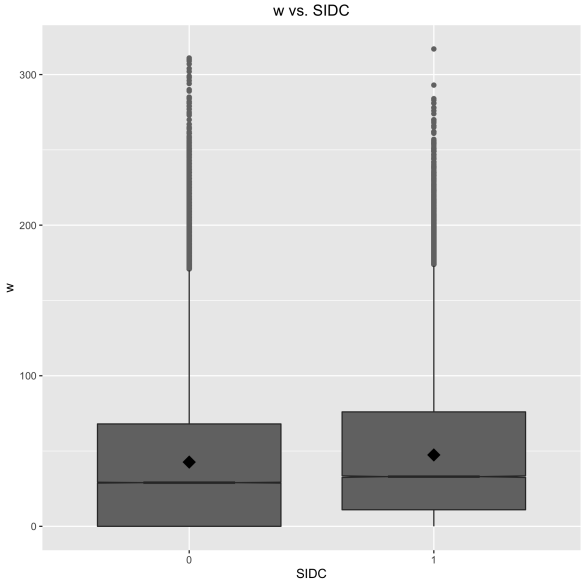

Figure 6: Box plots of raw Wolf number (w) by organization.

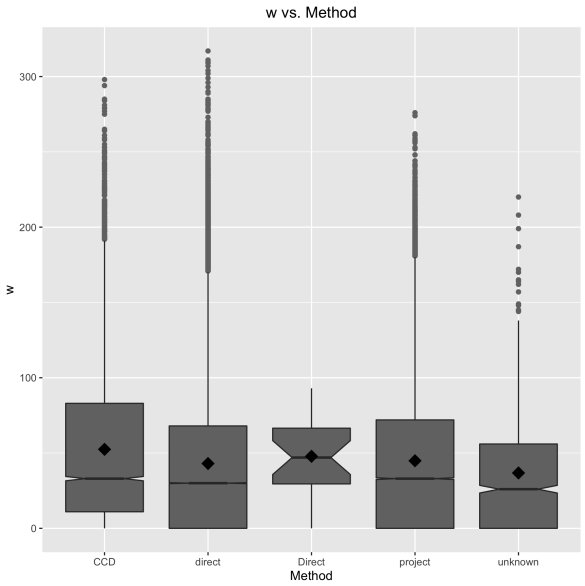

Figure 7: Box plots of raw Wolf number (w) by observer rank.

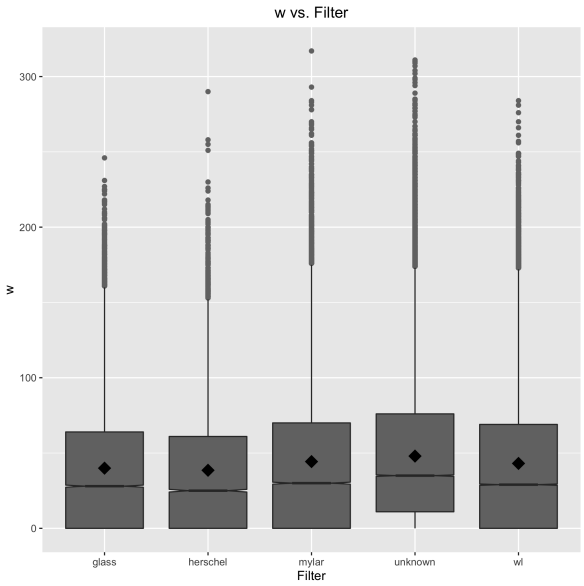

Figure 8: Box plots of raw Wolf number (w) by month and year.

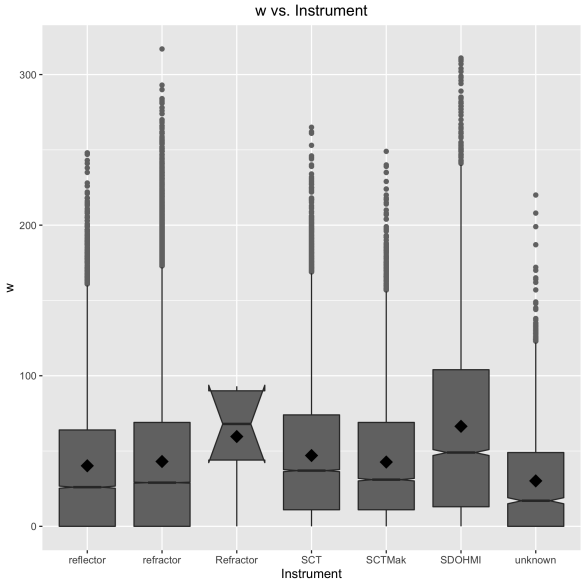

Figure 9: Box plots of raw Wolf number (w) by seeing condition.

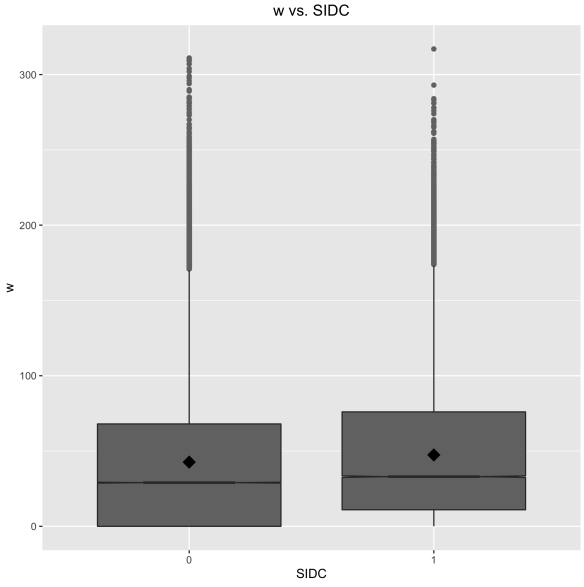

Figure 10: Box plots of raw Wolf number (w) by organization.

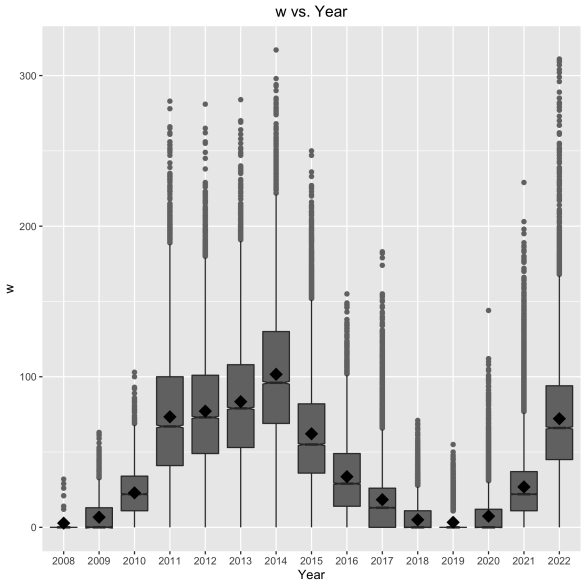

Figure 11: Box plots of raw Wolf number (w) by year.

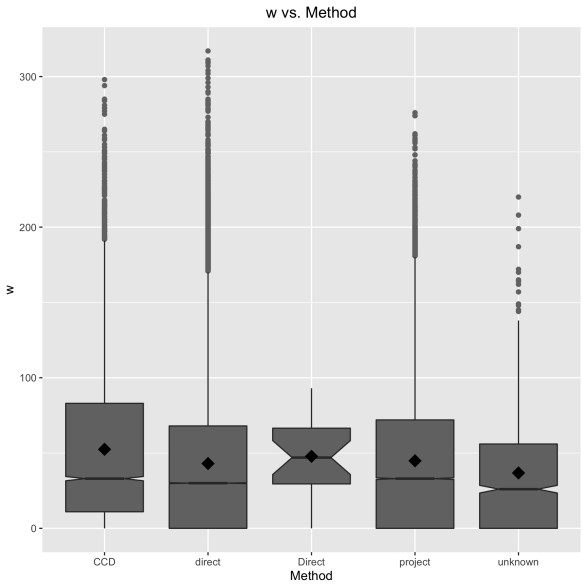

Figure 12: Box plots of raw Wolf number (w) by observing method.