



# Hemispheric Sunspot Numbers from the Astronomical Observatory of the University of Valencia (1940 – 1956)

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## Abstract

In this work, we present hemispheric sunspot number counts made in the Astronomical Observatory of the University of Valencia for the period 1940–1956. We found these data in a secondary source (the bulletins of the Madrid Astronomical Observatory). We digitized the hemispheric sunspot number and group number recorded by the observers. Unfortunately, the sunspot positions or areas were not published in this secondary source. A machine-readable version of the dataset is available as supplementary material. We compare the Valencia hemispheric series with others from other observatories, such as the Madrid Astronomical Observatory, finding similar hemispheric behaviors. We also computed the asymmetry index from the hemispheric data. We found that the northern hemisphere was predominant in our study period (declining phase of Solar Cycle 17, Solar Cycle 18, and rising phase of Solar Cycle 19), and the southern hemisphere was leading. These results agree with those obtained in previous studies. Therefore, the Valencia hemispheric records are one more piece of information to know the behavior of the northern and southern hemispheres during the 20th century.

**Keywords** Sunspot number · Sunspots · Statistics · Solar hemisphere · Solar cycle · Observations

## 1. Introduction

The sunspot number series is the most used index to characterize solar activity because it is based on the longest direct solar observation datasets (Muñoz-Jaramillo and Vaquero, 2019; Arlt and Vaquero, 2020). There are two families of indices based on the sunspot count. The first family is based on Rudolf Wolf's 19th-century idea that combines the counting of

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individual sunspots and groups of sunspots. The second family is based on the idea of Hoyt and Schatten (1998), which only considers the counting of groups of sunspots (Clette et al., 2014). The two main indices of the sunspot number series are the sunspot number,  $S_N$ , and the group number,  $G_N$  (Clette et al., 2015). New series using only the number of groups, as Hoyt and Schatten (1998), have been recently published (Svalgaard and Schatten, 2016; Usoskin et al., 2016; Chatzistergos et al., 2017; Velasco Herrera et al., 2022), as well as a newly revised collection of the group number database by Vaquero et al. (2016). In addition, a new revision of the sunspot number,  $S_N$ , was published in 2015 (Clette et al., 2016; Clette and Lefèvre, 2016).

The World Data Center of Sunspot Index and Long-term Solar Observations (SILSO) has been responsible for the maintenance of the sunspot number since 1980, when this task was transferred from Zürich to Brussels (Clette et al., 2007). Furthermore, SILSO has provided extended hemispheric numbers since 1874 (Temmer et al., 2006; Veronig et al., 2021). Studying the behavior of the two solar hemispheres, particularly its long-term evolution, can help us to better understand the solar dynamo (Schüssler and Cameron, 2018; Charbonneau, 2020). In the past, several works studied the solar hemispheric behavior. For example, Maunder (1904) published his famous butterfly diagram after studying the latitudinal distribution of sunspots. Ribes and Nesme-Ribes (1993) showed a strong asymmetry during the core of the Maunder Minimum (Eddy, 1976; Usoskin et al., 2015) when most sunspots were observed in the southern hemisphere. Also, Usoskin et al. (2009) showed an asymmetric sunspot occurrence (northern hemisphere dominating) just before the Dalton Minimum. The hemispheric behavior has also been analyzed for sunspot area and sunspot number by, for instance, Ballester, Oliver, and Carbonell (2005), Temmer et al. (2006), Deng et al. (2016), Veronig et al. (2021), and Aparicio et al. (2022). These latter authors used hemispheric sunspot observations made at the Madrid Astronomical Observatory (Spain).

The Astronomical Observatory of the University of Valencia (OV), located in Spain, recorded daily sunspot observations from the 1920s. Unfortunately, astronomical observations were interrupted for several years in the 1930s because a fire in the university destroyed the observatory (Rivas Sendra, 2009). The observations made in the OV in the 1920s were digitized and analyzed by Carrasco et al. (2014). In the present work, we have digitized and analyzed the hemispheric observations registered at the OV in 1940–1956. We present the records, the observers responsible for the observations, and the instruments used in Section 2. We show the Valencia hemispheric series and a comparison of this series with other hemispheric observations published in previous works, such as those from the Madrid Astronomical Observatory, another Spanish Observatory, by Aparicio et al. (2022) in Section 3. We computed and analyzed the asymmetry index, defined as the difference between both hemispheres, in Section 4. Finally, the main conclusions of this work are presented in Section 5.

## 2. Data

Sunspot observations were carried out in the OV during the 20th century (Rivas Sendra, 2009). The observations made in the OV in the 1920s were published yearly in the booklets of the observatory until 1931. The records of this first stage of the OV were digitized and analyzed by Carrasco et al. (2014). After this article, we found a second stage of OV sunspot observations from 1940 to 1956 in a secondary source: the bulletins of the Madrid Astronomical Observatory (see Appendix). An example page of this documentary source can be seen in Figure 1. In the present work, we present a machine-readable version of this dataset

OBSERVATORIO DE VALENCIA

CUADRO I

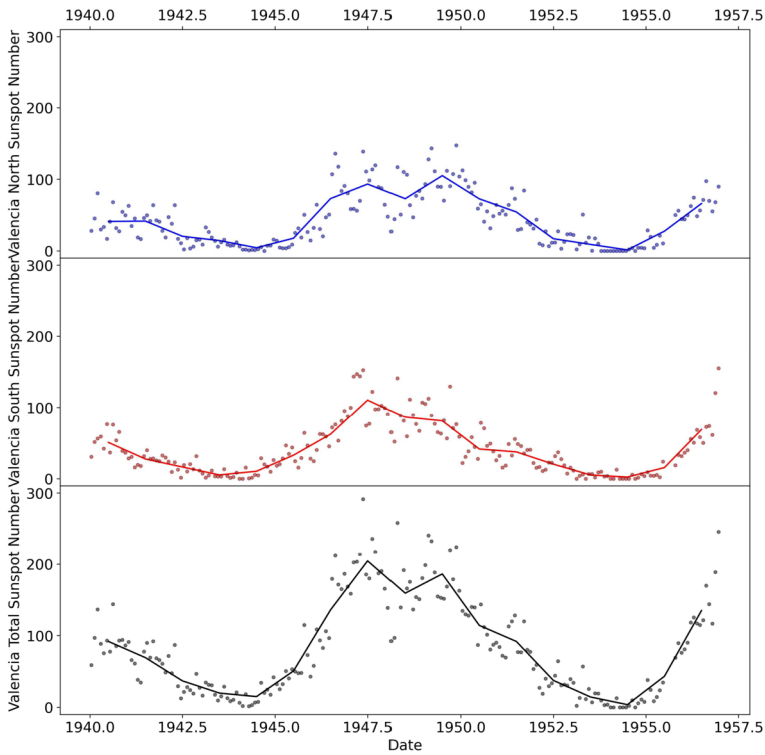
1947	D. R.	DISCO TOTAL		ZONA CENTRAL		CUADRANTES								Calidad.....	Observador.....	
		N.	W.	N.	W.	NW.		NE.		SW.		SE.				
						N.	W.	N.	W.	N.	W.	N.	W.			
<b>Rotación 1248</b>																
Enero.	2,46	9	7	99	1	13	2	25	2	38	2	23	1	13	B	M
	3,45	10	5	77	0	0	3	38	0	0	1	24	1	15	B	M
	5,51	12	4	58	0	0	2	27	1	14	0	0	1	17	R	M
	8,46	15	7	115	2	33	1	13	2	27	1	18	3	57	R	M A
	12,52	19	7	92	4	54	0	0	3	38	1	12	3	42	M	M
	14,46	21	12	295	6	172	1	29	2	40	3	124	6	102	B	M
	15,48	22	14	286	5	81	3	52	4	54	3	103	4	77	R	M A
	17,49	24	14	279	5	97	3	46	3	36	5	101	3	96	R	M

**Figure 1** An example page of the sunspot data recorded at the Astronomical Observatory of the University of Valencia in January 1947. The first column indicates the name of the month and fractional day of the observation (the year is indicated at the top left). The second column shows the order number of the day with respect to the solar synodic rotation. The third and fourth columns represent the number of groups and sunspot numbers for the whole disk. The two following columns contain the same information but only regarding the central zone of the solar disk (defined as a concentric disk of half the radius of the whole disk). Then, the number of groups and sunspots for the northwest, northeast, southwest, and southeast quadrants are shown, respectively. The two final columns represent the quality of the observations (B – good, R – regular, M – bad) and the responsible observer (Gullón, 1949, see Appendix).

and an analysis of the total and hemispheric sunspot observations made in OV from 1940 to 1956. We note that only the total and hemispheric sunspot number and group number have been published for the second stage of the OV (1940 – 1956), whereas a sunspot catalog including detailed information for each single sunspot was published for the first stage of the OV in the 1920s (Carrasco et al., 2014).

The second stage of the sunspot observations in the OV was an idea that arose when the observers of the Madrid Astronomical Observatory returned to Madrid after a temporary stay in Valencia due to the Spanish Civil War (1936 – 1939). Then, the director of the OV at that time, Vicente Martí, decided to continue with the sunspot observations from 1940 (Gullón, 1945). We also note that Gullón and López Arroyo (1958) reported that the publication of the OV observations in the bulletin of the Madrid Astronomical Observatory had to be stopped due to reasons beyond their control. Therefore, maybe sunspot observations were made in Valencia beyond 1956, but they were no longer published in the bulletins of Madrid Astronomical Observatory. Unfortunately, we have not found sunspot observations from Valencia after 1956.

The sunspot observations made in Valencia were carried out with a Grubb telescope of 15 cm in aperture and 2.2 m in focal length. The observation method consisted in projecting the image of the solar disk on a screen and fitting it to a 25 cm diameter circle, obtaining each day a drawing of the sunspots. The observers who made the sunspot observations for the period 1940 – 1956 in Valencia were Vicente Martí, Tomás Almer, José Chust, Mariano Aguilar, Rafael Peiró, Vicente Alberó, and two more anonymous observers. The astronomer

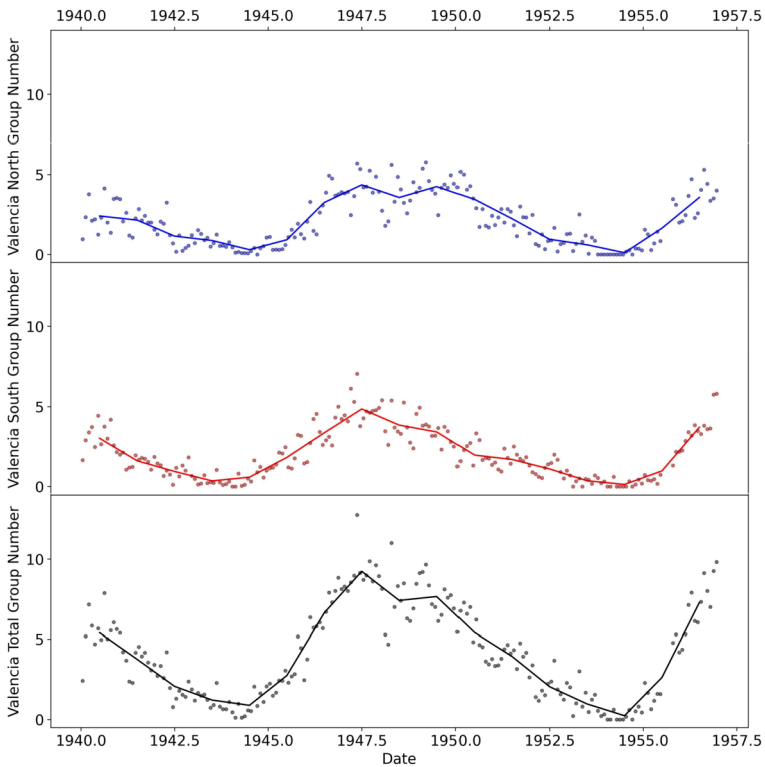


**Figure 2** North (*top panel*), south (*middle panel*), and total (*bottom panel*) sunspot numbers calculated from observations made at the Astronomical Observatory of the University of Valencia for the period 1940–1956. Monthly and yearly data are represented by *dots* and *continuous lines*, respectively.

responsible for each observation is indicated in the documentary source, and we have included that information in the machine-readable version. We note that Tomás Almer was responsible for the sunspot observations in the first stage of the OV in the 1920s using the same telescope as in the second stage, but with different methodology since observations were made by photography in that first stage (Carrasco et al., 2014).

We made a machine-readable version of the sunspot observations performed in OV for the period 1940–1956 including the total and hemispheric number of groups, and sunspot number. The hemispheric values of the sunspot number and group number were published split in solar quadrants (see Figure 1). Then, to construct the northern (southern) sunspot number of the hemispheric series, we added the sunspot number corresponding to the northwest and northeast (southwest and southeast) quadrants. The same was done to construct the hemispheric series of the number of groups. Figures 2 and 3 depict the Valencia total, north, and south sunspot number and group number, respectively, obtained in this work. Table 1 includes some examples of lines of the machine-readable version made in this work. This machine-readable version can be downloaded as supplementary material.

We note that the sunspot number values were calculated by the observers as  $R_V = 10 \cdot G + S$ , where  $G$  and  $S$  are the numbers of groups and single sunspots observed in the Valencia Observatory, respectively. The documentary source does not contain metadata on how observers counted groups in Valencia. However, we know that the Cortie classification was used in the observatory in the 1920s (Cortie, 1901; Carrasco et al., 2014, 2015). Therefore,



**Figure 3** North (*top panel*), south (*middle panel*), and total (*bottom panel*) group numbers computed from observations made at the Astronomical Observatory of the University of Valencia in 1940–1956. Monthly and yearly data are represented by *dots* and *continuous lines*, respectively.

it is probable that the observers followed this morphological classification of the group to define sunspot groups.

We also applied quality control to the digitized data to find digitization errors and inconsistencies in the records. For example, the maxima and minima of each variable were calculated to check if they were coherent. In addition, we checked that the sum of the values recorded in the four quadrants for each variable was equal to the value given for the total disk. If that was not the case, we analyzed it to identify the problem. The same procedure was followed, calculating monthly averages (from digitized daily values) and comparing them with those averages of the original source. Thus, we have corrected digitization errors and 53 typos detected in the original data. Moreover, we also identified 91 inconsistencies that could not be corrected, representing only 2% of the total data. One example is when one group is considered in two different quadrants. Uncorrected inconsistencies are included in our machine-readable version and are identified with the symbol “\*” in the column “Notes”.

### 3. Valencia Hemispheric Series: Analysis and Comparison with Previous Works

The number of observation days recorded in the OV in 1940–1956 was 6210, that is, a temporal coverage of 65% of the total days of that period. Thus, the annual mean of observation

**Table 1** Some example lines of the machine-readable version of the total and hemispheric sunspot observations published in this work. The first, second, and third columns represent the year, month, and day of the observation, respectively. The total group number and sunspot number are shown in the fourth and fifth columns. The numbers for the northern hemisphere are in the sixth and seventh columns, and for the southern hemisphere, in the eighth and ninth columns. The quality of the observation is indicated in the tenth column, the observer responsible for the observation in the eleventh column, and some notes on the observations are recorded in the last column. Detailed information is included in the supplementary material.

YEAR	MONTH	DAY	TOTAL-G	TOTAL-SN	NORTH-G	NORTH-SN	SOUTH-G	SOUTH-SN	QUALITY	OBSERVER	NOTE
1940	1	3	2	67	1	56	1	11	B	M	–
1944	1	1	0	0	0	0	0	0	R	M	–
1948	4	3	14	421	8	211	6	210	B	A	–

days is around 238. There is a gap in the OV observations from July to September (both included) 1955. Moreover, we note that the observations made in the OV in 1940 are not included in station N° 441 (Valencia Observatory) of the revised collection of sunspot groups by Vaquero et al. (2016). Thus, data from that year could be included in future versions of the group number database to extend the Valencia group number series.

The minimum of Solar Cycle 18 was in 1944 according to the yearly total and north sunspot number and group number, whereas in 1943 for the south sunspot number and group number. The maximum of Solar Cycle 18 was in 1947 in every case from Valencia data, except for the north sunspot number, it was in 1949 with a sunspot number slightly larger than that in 1947 (105 vs. 93). The minimum of Solar Cycle 19 was in 1954 in any of the Valencia sunspot number and group number series.

We note that, according to the yearly total values provided by SILSO, the minimum and maximum of Solar Cycle 18 were in 1944 and 1947, respectively, and the minimum of Solar Cycle 19 was in 1954. That behavior agrees with the one observed in the total series of Valencia. According to the hemispheric data provided by Veronig et al. (2021), the minimum of Solar Cycle 18 was in 1944 for the northern hemisphere and one year earlier for the southern one, and the maximum of that solar cycle was in 1949 and 1947 for the northern and southern hemispheres, respectively, and the minimum of Solar Cycle 19 was in 1954 in both cases. Thus, the only difference between the behavior of the Valencia hemispheric series and that reported by Veronig et al. (2021) is that the date of the maximum according to the Valencia group number for the northern hemisphere was in 1947, whereas it was in 1949 according to Veronig et al. (2021), such as it occurs in the case of the Valencia north sunspot number.

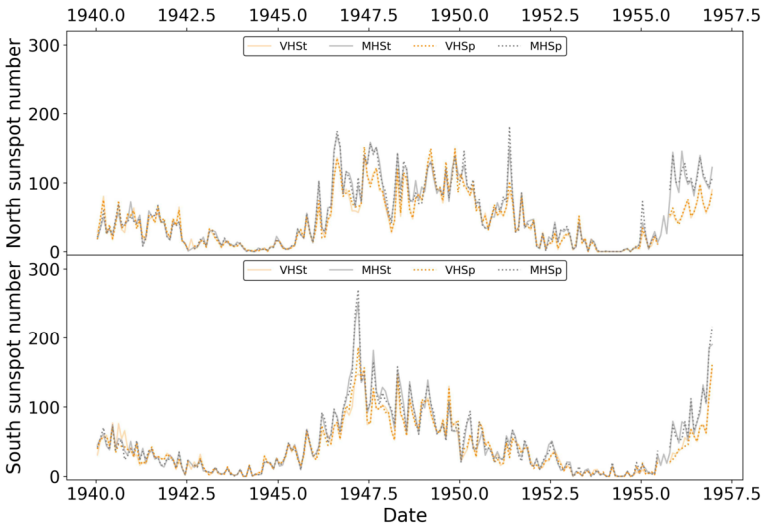
### 3.1. Comparison with the Madrid Astronomical Observatory

We compare the hemispheric sunspot observations made in OV with those made in another Spanish observatory: the Madrid Astronomical Observatory (Aparicio et al., 2014, 2022). Figure 4 depicts the comparison between the hemispheric series from Valencia (VHS) and Madrid (MHS) data. One can see the similarity between both series. The best linear fits taking into account monthly values computed from the 3347 common observation days between Valencia (VHSp) and Madrid (MHSp) are: 1)  $VHSp = (4.4 \pm 1.5) + (0.76 \pm 0.02) \cdot MHSp$ ,  $r = 0.931$ ,  $p$ -value  $< 0.001$  for the northern hemisphere, and 2)  $VHSp = (4.7 \pm 1.1) + (0.76 \pm 0.02) \cdot MHSp$ ,  $r = 0.956$ ,  $p$ -value  $< 0.001$  for the southern hemisphere.

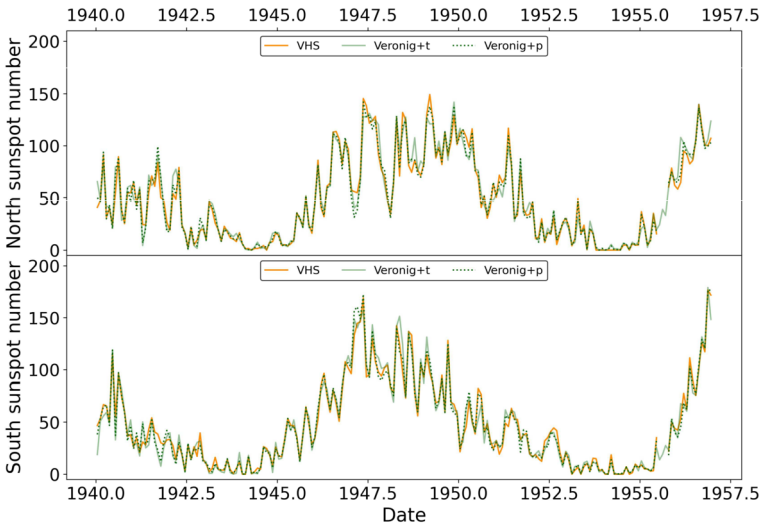
We have also calculated the ratio between Valencia and Madrid series. In general, the Madrid series presents larger values in both hemispheres than the Valencia series. The average ratio between Valencia and Madrid for the northern hemisphere is  $0.94 \pm 0.03$ , whereas  $0.94 \pm 0.02$  for the southern hemisphere. Moreover, the ratio in both cases ranged between 0.5 and 1.5 in around 90% of the monthly data. Variations of the ratio out of that range mainly occur during solar minima.

### 3.2. Comparison with the Hemispheric Series by Veronig et al. (2021)

We have also compared the Valencia hemispheric series with the hemispheric series published by Veronig et al. (2021) (hereafter, V21), who used data, for example, from the Royal Greenwich Observatory, to construct their hemispheric series. Following the methodology by V21, we have normalized the Valencia hemispheric series with respect to the sunspot number (version 2) provided by SILSO (see more details in V21). Figure 5 shows the comparison between the Valencia normalized hemispheric series and that from V21. The behavior of both series is close. The expressions for the best linear fits between VHS and



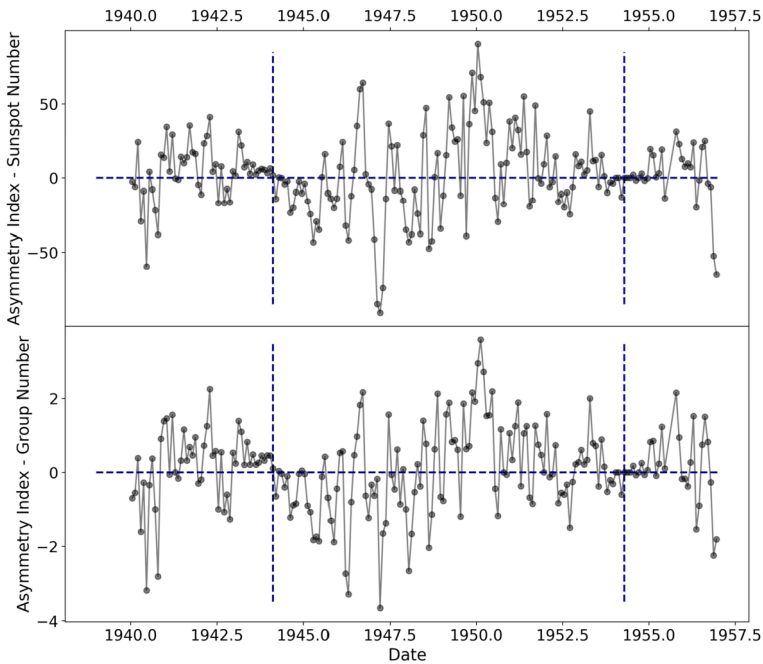
**Figure 4** Monthly north (*top panel*) and south (*bottom panel*) sunspot numbers from Valencia (*orange*) and Madrid (*grey*) hemispheric data. *Continuous lines* represent series with all observations recorded in each observatory (VHSt for Valencia and MHSt for Madrid), and *dotted lines* represent the series taking into account only the observation days in common between Valencia and Madrid (VHSp for Valencia and MHSp for Madrid).



**Figure 5** Monthly north (*top panel*) and south (*bottom panel*) sunspot numbers from Valencia (*orange*) and V21 (*green*) hemispheric data. *Continuous lines* represent series with all observations available in each series, and *dotted lines* represent the V21 series taking into account the observation days in common with Valencia. Note that these series are normalized to the sunspot number (version 2) provided by SILSO.

V21 series taking into account the common observation days are:  $VHS = (-0.03 \pm 0.61) + (1.00 \pm 0.01) V21$  with  $r = 0.991$  and  $p\text{-value} < 0.001$  for the northern hemisphere,





**Figure 6** Monthly asymmetry index according to the sunspot number (*top panel*) and group number (*bottom panel*) calculated from hemispheric sunspot observations recorded in the Astronomical Observatory of the University of Valencia in 1940–1956. *Horizontal dashed line* represents a value of the index equal to zero, and *vertical dashed lines* represent the dates of the minima of Solar Cycle 18 and 19 according to SILSO.

and  $VHS = (1.7 \pm 0.6) + (0.97 \pm 0.01) \cdot V21$  with  $r = 0.991$  and  $p\text{-value} < 0.001$  for the southern hemisphere.

The average ratio between both series, considering the same observation days, is  $0.99 \pm 0.03$  for the northern hemisphere and  $1.02 \pm 0.03$  for the southern one. Then, the ratio for the northern and southern hemispheres is similar. Moreover, more than 90% of the monthly ratio values are between 0.5 and 1.5 both in the northern and southern hemisphere cases. The largest variation of the ratio occurs around solar minima, such as in the case of the Valencia-Madrid ratio.

#### 4. Asymmetry Index

The asymmetry index has been calculated following the methodology used in previous works (Temmer et al., 2006; Veronig et al., 2021; Aparicio et al., 2022):  $\Delta = X_n - X_s$ , where  $\Delta$  is the absolute asymmetry,  $X_n$  is the sunspot number or group number for the northern hemisphere and  $X_s$  is the same for the southern hemisphere. Figure 6 shows the asymmetry index calculated from Valencia data in 1940–1956. Vertical dashed lines represent the minima of Solar Cycle 18 (February 1944) and 19 (April 1954) according to the 13-month smoothed sunspot number values provided by SILSO.

We have also calculated the cumulative monthly hemispheric Valencia series as the sum of all the hemispheric values for each hemispheric series from Valencia data. This information is included in Table 2 for the Valencia hemispheric sunspot number and Table 3 for

**Table 2** Hemispheric asymmetry computed from the sunspot number calculated from the observations made in the Astronomical Observatory of the University of Valencia in 1940–1956. The first column represents the solar cycle number, the second and third columns depict the maximum sunspot number value for the northern and southern hemispheres, respectively, fourth and fifth columns are the sum of the monthly values of the asymmetry index for the northern and southern hemispheres, respectively, the sixth column contains the difference between the northern and southern cumulative values, the seventh column indicates the predominant hemisphere, and the eighth column shows the difference in percentage between both hemispheres, calculated as the ratio between the difference of the hemispheric cumulative values and the lowest hemispheric cumulative value.

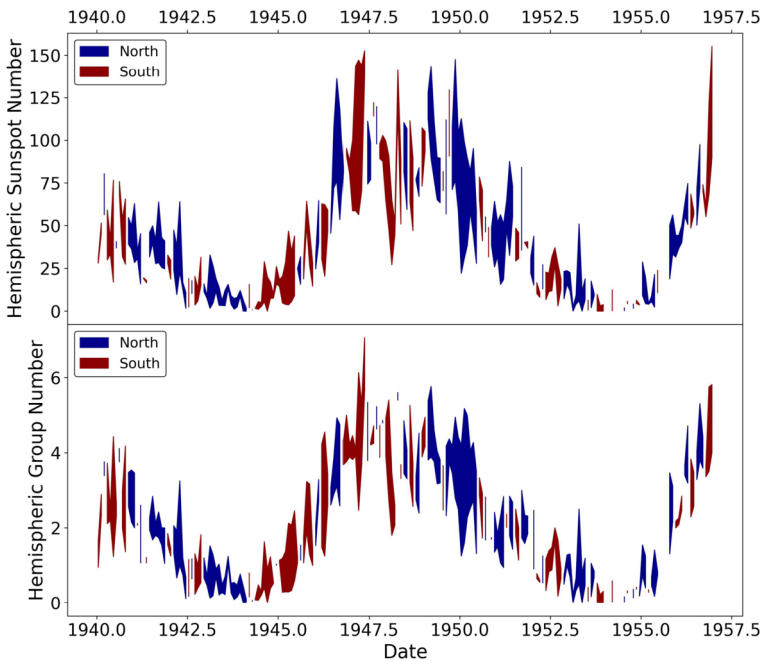
Solar Cycle	Max. N-SN	Max. S-SN	Cumul. North	Cumul. South	Cumul. Asymmetry	Predom. Hemisphere	Dif. [%]
17	80.5	76.6	1435	1218	217	North	17.8
18	147.6	152.7	6156	5949	206	North	3.5
19	97.4	155.3	1052	995	57	North	5.8

**Table 3** Hemispheric asymmetry computed from the group number recorded in the Astronomical Observatory of the University of Valencia for the period 1940–1956. The first column represents the solar cycle number, second and third columns depict the maximum group number for the northern and southern hemispheres, respectively, the fourth and fifth columns are the sum of the monthly values of the asymmetry index for the northern and southern hemispheres, respectively, the sixth column contains the difference between the northern and southern cumulative values, the seventh column indicates the predominant hemisphere, and the eighth column shows the difference in percentage between both hemispheres, calculated as the ratio between the difference of the hemispheric cumulative values and the lowest hemispheric cumulative value.

Solar Cycle	Max. N-GN	Max. S-GN	Cumul. North	Cumul. South	Cumul. Asymmetry	Predom. Hemisphere	Dif. [%]
17	4.1	4.4	80	72	8	North	10.7
18	5.8	7.1	284	279	5	North	1.8
19	5.3	5.8	58	54	4	North	7.2

the Valencia hemispheric group number. Information on the maximum and minimum values for Solar Cycles 17–19 according to the Valencia hemispheric data, the predominant hemisphere, and the difference in percentage between both hemispheres is also included in Table 2 and 3. Note that only Solar Cycle 18 is fully covered by the data, while the declining phase for Solar Cycle 17 and the rising phase for Solar Cycle 19 are just covered. Furthermore, we show the monthly difference between the Valencia hemispheric series in Figure 7, where the excess of the northern hemisphere with respect to the southern one is represented by blue color and the opposite case in red.

The largest hemispheric sunspot number and group number values in each solar cycle from Valencia data for the southern hemisphere were higher than those for the northern hemisphere, except in the case of the maximum sunspot number in Solar Cycle 17 when the hemispheric value of the northern hemisphere was larger (see Table 2 and 3). However, the cumulative asymmetry is positive in all the cases, that is the northern hemisphere was predominant during the declining phase of Solar Cycle 17, in Solar Cycle 18, and in the rising phase of Solar Cycle 19. The largest relative difference between the two hemispheres is found in Solar Cycle 17, both in the sunspot number (18%) and the group number (11%), whereas it is below 10% in Solar Cycles 18 and 19. We note that our results are similar to those of Aparicio et al. (2022) using data from the Madrid Astronomical Observatory. We note that the relative difference between hemispheres obtained by Aparicio et al. (2022) in



**Figure 7** Monthly differences between the Valencia hemispheric sunspot number (*top panel*) and group number (*bottom panel*) series for the period 1940–1956. The excess of the north (south) with respect to the south (north) is represented in *blue (red)* color.

Solar Cycle 19 (39%) is significantly larger than that in our work (5–10%). The reason may be that only the rising phase of Solar Cycle 19 is covered by the Valencia hemispheric observations (30 months), whereas the cycle was recorded in the Madrid Astronomical Observatory (117 months).

The largest values of the monthly asymmetry index in the case of the Valencia hemispheric sunspot number are  $-59.6$  for Solar Cycle 17,  $-90.8$  for Solar Cycle 18, and  $-65.3$  for Solar Cycle 19. In the case of the Valencia hemispheric group number, they are  $-3.2$  for Solar Cycle 17,  $-3.7$  for Solar Cycle 18, and  $-2.3$  for Solar Cycle 19. Here, we determined some differences with respect to the largest values of the monthly asymmetry index by Aparicio et al. (2022) using the Madrid sunspot number. First, we found that all the largest monthly values of the asymmetry for each solar cycle are negative (south exceeding), while they are positive for Solar Cycle 17 (93) and 19 (162) and negative ( $-159$ ) for Solar Cycle 18 according to Aparicio et al. (2022). As in the previous analysis, the reason for the difference is that the OV did not register the whole Solar Cycle 17 and 19. Considering the same observation period in Madrid and Valencia (1940–1956), the largest monthly values of the asymmetry calculated from Madrid data for each solar cycle are also negative. For example, regarding the sunspot number, they are  $-49.7$  for Solar Cycle 17,  $-159.4$  for Solar Cycle 18, and  $-94.4$  for Solar Cycle 19. Thus, the largest monthly asymmetry values for Solar Cycle 17 from Valencia and Madrid data are similar, but they are significantly larger in Aparicio et al. (2022) for Solar Cycles 18 and 19. Moreover, no monthly asymmetry value is above 100 in terms of sunspot number in this work, unlike in Aparicio et al. (2022). Perhaps this happens because the values of the total and hemispheric Madrid series are significantly higher than the Valencia ones for the whole series (not only for the extreme cases).

Finally, one can also see from Figures 2, 3, and 7 that the southern hemisphere preceded the northern hemisphere during the observation period studied in this work. This is in agreement with previous works such as Veronig et al. (2021) and Aparicio et al. (2022), as well as with the hemispheric secular trends found by Zolotova et al. (2010), who showed that the southern hemisphere led between 1928 and 1968.

## 5. Conclusions

Sunspot observations were made in the Astronomical Observatory of the University of Valencia (OV) (Spain) during the 20th century. The first sunspot records, published in the booklets of the observatory, were carried out in the 1920s. These were digitized and analyzed by Carrasco et al. (2014). We found a second stage of sunspot observations made in OV (1940–1956) in a secondary documentary source: the bulletins published by the Madrid Astronomical Observatory. In this work, we have digitized and analyzed the hemispheric observations made in the Astronomical Observatory of the University of Valencia (Spain) for the period 1940–1956. A machine-readable version of these records is available as supplementary material.

We have also compared the Valencia hemispheric series with others published in previous works. We found close behaviors between the Valencia series and those by Aparicio et al. (2022) from Madrid and between the Valencia series normalized to the sunspot number and those by V21. The correlation coefficients, regarding the same observation days, between Valencia and Madrid, are  $r = 0.931$  and  $r = 0.956$  for the northern and southern hemispheres, respectively, and they are  $r = 0.991$  both for the northern and southern hemispheres between Valencia and V21.

We have calculated the hemispheric asymmetry index from Valencia sunspot observations. We obtained that the northern hemisphere was predominant in the observation period when sunspot observations were recorded in Valencia (declining phase of Solar Cycle 17, Solar Cycle 18, and rising phase of Solar Cycle 19). This agrees with the results found in previous works, such as that by Aparicio et al. (2022), using data from the Madrid Astronomical Observatory (Spain). Moreover, we found that the southern hemisphere led with respect to the northern one in the observation period studied in this work. This also agrees with previous works such as Veronig et al. (2021) and the hemispheric secular trends noted by Zolotova et al. (2010).

Thus, we provide new hemispheric observations from Valencia not available digitally so far, which can help reduce weaknesses detected by Lefèvre and Clette (2014) in past solar data because of limited temporal coverage overlap. The recovery of this kind of hemispheric data is fundamental to constructing long homogenized series.

## Appendix

Gullón, E.: 1944, Actividad solar en 1940. Observaciones de manchas solares efectuadas en los Observatorios de Madrid y Valencia, *Boletín Astronómico del Observatorio de Madrid III* (1), 37.

Gullón, E.: 1944, Actividad solar en 1941. Resumen de las observaciones realizadas en los Observatorios de Madrid, Valencia y Cartuja. *Boletín Astronómico del Observatorio de Madrid III* (2), 29.

- Gullón, E.: 1945, Actividad solar en 1942. Observaciones de manchas solares realizadas en el Observatorio de la Universidad de Valencia. *Boletín Astronómico del Observatorio de Madrid III* (3), 9.
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## Declarations

**Competing Interests** The authors declare no competing interests.

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