

# Annual Report on Sunspot Counting Program

2017

Vol. 5

Universidad de Extremadura, Spain



This *Annual Report on Sunspot Counting Program 2017* was compiled by A. J. P. Aparicio, N. Bravo-Paredes, and J. M. Vaquero.

## Introduction

This program was born in late 2012 at the University of Extremadura (Badajoz, 38°53' N 6°58' W) in order to further extend our research in the reconstruction of past solar activity (see, for example, Vaquero, 2007). Since 1st January 2013, our sunspot counts have been submitted to the Royal Observatory of Belgium (ROB) as a contribution to the international effort of maintaining and updating the International Sunspot Number. For this purpose, we use a small apochromatic refractor –80 mm of objective diameter and 550 mm of focal length– to project a 150 mm diameter image onto a template. Then, a drawing is done so we obtain our sunspot counts from it.

In this report, we provide a complete set of data obtained throughout the year 2017, with four tables showing our data. Moreover, the reference sunspot index is compared with our results.

We hope that this publication is useful to the scientific community studying the sunspot number: the longest solar index series derived from direct observation of the Sun.

## Data

Table 1 lists all the observations made along this year. A few days reflect more than one observation. In such cases, we follow the ROB criteria to choose the best drawing of each day, that is, we choose the observation showing (in order of priority):

- Highest number of groups
- Highest Wolf number
- Highest Quality
- Smallest time-difference with respect to 12:00 UT (solar culmination)
- Early-in-the-morning counts are best

Note that the drawing quality is represented as an integer number between 1 and 5, according to the following rule (USSPS code):

- 1 = very poor
- 2 = poor
- 3 = fair
- 4 = good
- 5 = exceptional

Tables 2 and 3 list daily, monthly, and yearly values of the number of groups and spots along 2017. From the group count  $G$  and the sunspot count  $S$ , we define the UEx sunspot number (or UEx Wolf number) as follows:  $SN_{UEx} = 10G + S$ . Additionally, we define the UEx group sunspot number as:  $GSN_{UEx} = 12.08G$ . These definitions are in agreement with the classical ones (Clette *et al.*, 2014, 2016). Thus, Table 4 lists daily, monthly, and yearly values of  $SN_{UEx}$ , while Figure 1 shows the temporal evolution of these indexes.

Table 1. Data on sunspot counting along 2017, including month, day, time (UT), observer, quality, number of groups ( $G$ ), number of spots ( $S$ ), and Wolf number ( $SN_{UEX}$ ).

Month	Day	Time (UT)	Observer	Quality	$G$	$S$	$SN_{UEX}$
1	1	13:00	JM Vaquero	2	1	2	12
1	5	14:30	AJP Aparicio	3	0	0	0
1	6	16:15	JM Vaquero	3	0	0	0
1	7	14:05	JM Vaquero	2	0	0	0
1	8	16:35	JM Vaquero	3	0	0	0
1	9	13:15	JM Vaquero	3	0	0	0
1	10	12:30	AJP Aparicio	2	0	0	0
1	11	10:25	AJP Aparicio	2	0	0	0
1	12	9:55	AJP Aparicio	4	0	0	0
1	13	13:00	JM Vaquero	2	2	3	23
1	13	13:03	AJP Aparicio	2	2	3	23
1	14	12:20	AJP Aparicio	3	2	3	23
1	15	10:30	AJP Aparicio	4	2	3	23
1	16	12:40	AJP Aparicio	4	2	4	24
1	17	10:50	AJP Aparicio	5	2	8	28
1	18	10:55	AJP Aparicio	2	2	7	27
1	19	11:10	AJP Aparicio	3	2	6	26
1	21	12:40	AJP Aparicio	2	4	32	72
1	22	12:20	AJP Aparicio	3	3	30	60
1	23	11:10	AJP Aparicio	3	3	19	49
1	24	10:05	AJP Aparicio	3	2	10	30
1	25	12:15	AJP Aparicio	5	2	24	44
1	28	10:45	JM Vaquero	2	2	7	27
1	30	10:15	AJP Aparicio	4	2	2	22
2	1	11:25	AJP Aparicio	1	2	6	26
2	5	13:10	AJP Aparicio	2	0	0	0
2	6	13:25	AJP Aparicio	3	0	0	0
2	8	10:20	AJP Aparicio	3	0	0	0
2	10	9:10	AJP Aparicio	3	1	13	23
2	13	12:50	AJP Aparicio	1	1	3	13
2	14	9:25	N Bravo-Paredes	1	1	2	12
2	16	8:25	AJP Aparicio	1	0	0	0
2	17	9:25	AJP Aparicio	2	0	0	0
2	19	12:25	AJP Aparicio	3	0	0	0
2	20	13:45	AJP Aparicio	2	2	3	23
2	21	10:30	AJP Aparicio	1	2	6	26
2	21	13:05	I Tovar	1	2	3	23
2	22	11:00	AJP Aparicio	2	2	9	29
2	24	13:20	AJP Aparicio	1	1	1	11
2	25	12:45	AJP Aparicio	2	2	2	22
2	26	12:15	VMS Carrasco	1	1	1	11

2	28	11:50	AJP Aparicio	3	4	15	55
3	1	12:00	AJP Aparicio	3	4	16	56
3	2	13:44	L Bautista	2	4	10	50
3	7	11:05	AJP Aparicio	2	0	0	0
3	8	9:20	AJP Aparicio	2	0	0	0
3	9	13:20	L Bautista	2	0	0	0
3	10	9:48	I Tovar	2	0	0	0
3	11	12:30	AJP Aparicio	2	0	0	0
3	13	9:20	AJP Aparicio	3	0	0	0
3	15	10:20	AJP Aparicio	3	0	0	0
3	15	13:45	J Navarro	2	0	0	0
3	18	13:22	JM Vaquero	2	0	0	0
3	21	13:10	AJP Aparicio	3	0	0	0
3	23	9:20	AJP Aparicio	3	1	2	12
3	24	11:30	AJP Aparicio	3	1	3	13
3	25	11:50	AJP Aparicio	4	1	2	12
3	27	12:40	AJP Aparicio	1	3	13	43
3	28	13:00	AJP Aparicio	2	2	22	42
3	29	9:15	AJP Aparicio	5	2	24	44
3	29	13:15	J Muñoz	3	2	18	38
3	30	11:45	AJP Aparicio	2	2	25	45
3	31	11:30	AJP Aparicio	4	2	29	49
3	31	11:50	L Bautista	3	2	28	48
4	1	12:25	AJP Aparicio	3	2	37	57
4	2	12:00	AJP Aparicio	3	2	52	72
4	3	8:20	J Muñoz	3	4	62	102
4	4	9:30	AJP Aparicio	3	3	29	59
4	5	8:45	AJP Aparicio	4	2	24	44
4	6	8:05	AJP Aparicio	4	2	21	41
4	7	8:05	AJP Aparicio	4	1	5	15
4	8	10:55	AJP Aparicio	4	0	0	0
4	9	11:50	AJP Aparicio	2	0	0	0
4	10	9:00	AJP Aparicio	2	1	2	12
4	11	8:15	AJP Aparicio	4	1	2	12
4	12	7:40	AJP Aparicio	4	1	3	13
4	18	8:00	AJP Aparicio	2	2	3	23
4	19	8:50	AJP Aparicio	3	1	3	13
4	19	9:36	J Navarro	2	1	3	13
4	20	12:20	AJP Aparicio	2	2	6	26
4	21	8:40	AJP Aparicio	2	3	13	43
4	23	11:40	AJP Aparicio	2	2	5	25
4	24	13:20	AJP Aparicio	1	3	14	44
4	25	11:50	AJP Aparicio	4	3	6	36
4	27	8:20	AJP Aparicio	4	2	5	25
5	2	8:20	AJP Aparicio	4	2	9	29

5	3	8:15	AJP Aparicio	4	1	6	16
5	5	8:30	AJP Aparicio	2	2	11	31
5	5	10:24	I Tovar	3	2	6	26
5	6	11:10	AJP Aparicio	1	1	1	11
5	7	10:20	AJP Aparicio	3	2	3	23
5	8	8:20	AJP Aparicio	3	0	0	0
5	9	9:55	AJP Aparicio	3	0	0	0
5	10	8:40	AJP Aparicio	4	0	0	0
5	14	9:45	AJP Aparicio	3	0	0	0
5	16	8:20	JM Vaquero	3	2	3	23
5	17	9:30	AJP Aparicio	3	1	1	11
5	18	9:00	AJP Aparicio	4	1	1	11
5	19	8:15	AJP Aparicio	3	2	3	23
5	23	8:25	AJP Aparicio	4	4	11	51
5	24	8:25	AJP Aparicio	3	1	10	20
5	25	8:30	AJP Aparicio	3	1	10	20
5	30	8:25	AJP Aparicio	3	0	0	0
5	31	8:55	AJP Aparicio	3	0	0	0
6	1	8:25	AJP Aparicio	4	1	2	12
6	2	8:20	AJP Aparicio	2	1	13	23
6	5	10:15	AJP Aparicio	3	1	14	24
6	6	7:55	AJP Aparicio	5	1	14	24
6	7	8:15	AJP Aparicio	4	1	3	13
6	8	7:55	AJP Aparicio	4	1	5	15
6	9	8:25	AJP Aparicio	2	0	0	0
6	10	11:25	AJP Aparicio	2	0	0	0
6	11	9:35	AJP Aparicio	2	0	0	0
6	12	8:35	AJP Aparicio	4	0	0	0
6	13	8:40	AJP Aparicio	3	1	1	11
6	14	8:00	AJP Aparicio	3	1	1	11
6	15	8:25	AJP Aparicio	3	2	7	27
6	16	8:55	AJP Aparicio	3	2	9	29
6	18	10:25	AJP Aparicio	2	2	8	28
6	19	9:10	AJP Aparicio	2	2	5	25
6	25	17:00	JM Vaquero	2	1	6	16
6	26	8:55	AJP Aparicio	3	1	10	20
6	27	8:50	AJP Aparicio	3	1	8	18
6	30	7:55	AJP Aparicio	3	1	1	11
7	1	12:30	AJP Aparicio	1	1	1	11
7	2	12:05	AJP Aparicio	2	1	1	11
7	3	7:50	AJP Aparicio	3	0	0	0
7	4	7:55	AJP Aparicio	3	0	0	0
7	6	8:00	AJP Aparicio	3	1	2	12
7	7	7:40	AJP Aparicio	4	1	12	22
7	8	11:20	AJP Aparicio	2	1	17	27

7	9	12:10	AJP Aparicio	3	2	31	51
7	10	9:40	AJP Aparicio	2	1	29	39
7	11	8:10	AJP Aparicio	3	1	25	35
7	12	8:05	AJP Aparicio	4	2	24	44
7	13	8:10	AJP Aparicio	5	2	33	53
7	14	7:55	AJP Aparicio	3	2	19	39
7	18	8:05	AJP Aparicio	4	0	0	0
7	19	7:50	AJP Aparicio	3	0	0	0
7	20	8:05	AJP Aparicio	4	0	0	0
7	21	8:30	AJP Aparicio	4	0	0	0
7	22	12:00	AJP Aparicio	2	0	0	0
7	23	10:55	AJP Aparicio	3	0	0	0
7	24	8:45	AJP Aparicio	4	0	0	0
7	25	8:05	AJP Aparicio	4	0	0	0
7	26	8:25	AJP Aparicio	4	0	0	0
7	27	8:05	AJP Aparicio	3	0	0	0
7	28	8:20	AJP Aparicio	3	0	0	0
7	29	10:40	AJP Aparicio	3	0	0	0
7	30	10:35	AJP Aparicio	3	0	0	0
7	31	9:05	AJP Aparicio	3	0	0	0
8	1	9:25	AJP Aparicio	3	1	1	11
8	2	8:45	AJP Aparicio	3	1	2	12
8	3	8:40	AJP Aparicio	4	1	2	12
8	4	8:05	AJP Aparicio	5	1	2	12
8	17	15:00	JM Vaquero	3	2	18	38
8	23	10:30	JM Vaquero	3	3	19	49
8	28	10:20	JM Vaquero	2	1	5	15
9	1	9:25	JM Vaquero	3	4	19	59
9	2	17:45	JM Vaquero	3	4	27	67
9	4	9:25	JM Vaquero	3	5	47	97
9	11	8:25	N Bravo-Paredes	3	1	1	11
9	12	7:10	JM Vaquero	2	1	1	11
9	12	8:10	N Bravo-Paredes	3	1	1	11
9	13	7:40	N Bravo-Paredes	2	1	1	11
9	14	8:10	N Bravo-Paredes	1	1	1	11
9	15	7:55	N Bravo-Paredes	2	1	1	11
9	18	7:45	N Bravo-Paredes	2	1	1	11
9	19	7:20	N Bravo-Paredes	2	1	1	11
9	20	8:20	N Bravo-Paredes	2	1	1	11
9	21	10:00	N Bravo-Paredes	1	1	1	11
9	22	8:45	N Bravo-Paredes	2	1	1	11
9	23	9:15	N Bravo-Paredes	3	1	2	12
9	23	17:25	JM Vaquero	2	1	1	11
9	24	9:10	N Bravo-Paredes	3	1	2	12
9	25	8:55	N Bravo-Paredes	3	2	3	23

9	26	15:35	N Bravo-Paredes	5	3	9	39
9	27	8:55	N Bravo-Paredes	3	3	6	36
9	28	9:40	N Bravo-Paredes	3	3	7	37
9	29	11:00	N Bravo-Paredes	3	3	5	35
10	2	8:05	N Bravo-Paredes	3	2	3	23
10	3	7:15	N Bravo-Paredes	2	2	3	23
10	4	9:20	N Bravo-Paredes	2	2	3	23
10	5	7:35	N Bravo-Paredes	2	2	3	23
10	8	9:00	N Bravo-Paredes	3	0	0	0
10	9	7:45	N Bravo-Paredes	3	0	0	0
10	10	9:45	N Bravo-Paredes	2	0	0	0
10	11	8:45	N Bravo-Paredes	3	0	0	0
10	16	8:15	N Bravo-Paredes	2	0	0	0
10	19	8:55	N Bravo-Paredes	3	0	0	0
10	22	9:55	N Bravo-Paredes	3	1	2	12
10	23	8:50	N Bravo-Paredes	3	1	1	11
10	24	8:05	N Bravo-Paredes	2	2	2	22
10	25	9:15	N Bravo-Paredes	3	2	2	22
10	26	10:05	N Bravo-Paredes	3	2	3	23
10	27	9:45	N Bravo-Paredes	3	2	3	23
10	28	10:15	N Bravo-Paredes	3	2	3	23
10	30	9:35	N Bravo-Paredes	3	2	2	22
10	31	9:55	N Bravo-Paredes	3	1	1	11
11	3	15:10	N Bravo-Paredes	3	0	0	0
11	6	9:40	VMS Carrasco	4	0	0	0
11	7	9:00	N Bravo-Paredes	3	0	0	0
11	8	10:50	N Bravo-Paredes	3	0	0	0
11	9	9:20	N Bravo-Paredes	5	0	0	0
11	10	10:05	N Bravo-Paredes	4	0	0	0
11	11	14:05	JM Vaquero	3	0	0	0
11	13	10:00	N Bravo-Paredes	3	0	0	0
11	14	9:00	N Bravo-Paredes	3	1	3	13
11	15	10:45	N Bravo-Paredes	3	1	2	12
11	16	10:20	N Bravo-Paredes	2	1	2	12
11	17	10:40	N Bravo-Paredes	3	1	4	14
11	18	12:20	N Bravo-Paredes	2	0	0	0
11	19	11:20	N Bravo-Paredes	3	0	0	0
11	20	10:10	N Bravo-Paredes	4	0	0	0
11	21	8:55	N Bravo-Paredes	4	0	0	0
11	22	10:15	N Bravo-Paredes	1	0	0	0
11	24	11:35	N Bravo-Paredes	2	0	0	0
11	27	10:35	N Bravo-Paredes	1	1	2	12
11	29	10:00	N Bravo-Paredes	2	1	1	11
11	30	12:00	N Bravo-Paredes	3	0	0	0
12	1	10:20	N Bravo-Paredes	3	0	0	0



12	2	11:00	N Bravo-Paredes	3	0	0	0
12	3	11:40	N Bravo-Paredes	3	0	0	0
12	4	11:00	N Bravo-Paredes	3	0	0	0
12	5	11:05	N Bravo-Paredes	2	0	0	0
12	6	13:30	AJP Aparicio	1	1	3	13
12	7	10:50	AJP Aparicio	2	1	1	11
12	11	11:13	AJP Aparicio	4	0	0	0
12	12	11:15	N Bravo-Paredes	3	1	2	12
12	13	10:30	AJP Aparicio	2	0	0	0
12	16	13:05	N Bravo-Paredes	2	0	0	0
12	18	11:07	N Bravo-Paredes	2	0	0	0
12	19	10:25	AJP Aparicio	2	0	0	0
12	20	10:15	N Bravo-Paredes	3	1	3	13
12	21	10:25	AJP Aparicio	5	1	17	27
12	22	10:45	N Bravo-Paredes	2	1	9	19
12	23	16:25	JM Vaquero	2	1	12	22
12	25	13:00	JM Vaquero	1	1	7	17

Total number of observations: 238

Total number of days recorded: 229

Table 2. Daily, monthly, and yearly values of number of groups ( $G$ ) in 2017.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	1	2	4	2		1	1	1	4			0
2			4	2	2	1	1	1	4	2		0
3				4	1		0	1		2	0	0
4				3			0	1	5	2		0
5	0	0		2	2	1				2		0
6	0	0		2	1	1	1				0	1
7	0		0	1	2	1	1				0	1
8	0	0	0	0	0	1	1			0	0	
9	0		0	0	0	0	2			0	0	
10	0	1	0	1	0	0	1			0	0	
11	0		0	1		0	1		1	0	0	0
12	0			1		0	2		1			1
13	2	1	0			1	2		1		0	0
14	2	1			0	1	2		1		1	
15	2		0			2			1		1	
16	2	0			2	2				0	1	0
17	2	0			1			2			1	
18	2		0	2	1	2	0		1		0	0
19	2	0		1	2	2	0		1	0	0	0
20		2		2			0		1		0	1
21	4	2	0	3			0		1		0	1
22	3	2					0		1	1	0	1
23	3		1	2	4		0	3	1	1		1
24	2	1	1	3	1		0		1	2	0	
25	2	2	1	3	1	1	0		2	2		1
26		1				1	0		3	2		
27			3	2		1	0		3	2	1	
28	2	4	2				0	1	3	2		
29			2				0		3		1	
30	2		2		0	1	0			2	0	
31			2		0		0			1		
Monthly mean	1.4	1.1	1.2	1.9	1.1	1.0	0.6	1.4	2.0	1.2	0.3	0.4
Yearly mean	1.1											

Table 3. Daily, monthly, and yearly values of number of spots ( $S$ ) in 2017.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	2	6	16	37		2	1	1	19			0
2			10	52	9	13	1	2	27	3		0
3				62	6		0	2		3	0	0
4				29			0	2	47	3		0
5	0	0		24	11	14				3		0
6	0	0		21	1	14	2				0	3
7	0		0	5	3	3	12				0	1
8	0	0	0	0	0	5	17			0	0	
9	0		0	0	0	0	31			0	0	
10	0	13	0	2	0	0	29			0	0	
11	0		0	2		0	25		1	0	0	0
12	0			3		0	24		1			2
13	3	3	0			1	33		1		0	0
14	3	2			0	1	19		1		3	
15	3		0			7			1		2	
16	4	0			3	9				0	2	0
17	8	0			1			18			4	
18	7		0	3	1	8	0		1		0	0
19	6	0		3	3	5	0		1	0	0	0
20		3		6			0		1		0	3
21	32	6	0	13			0		1		0	17
22	30	9					0		1	2	0	9
23	19		2	5	11		0	19	2	1		12
24	10	1	3	14	10		0		2	2	0	
25	24	2	2	6	10	6	0		3	2		7
26		1				10	0		9	3		
27			13	5		8	0		6	3	2	
28	7	15	22				0	5	7	3		
29			24				0		5		1	
30	2		25		0	1	0			2	0	
31			29		0		0			1		
Monthly mean	7.0	3.6	7.7	14.6	3.8	5.4	7.2	7.0	6.9	1.6	0.7	3.0
Yearly mean	5.7											

Table 4. Daily, monthly, and yearly values of Wolf number ( $SN_{UEX}$ ) in 2017.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	12	26	56	57		12	11	11	59			0
2			50	72	29	23	11	12	67	23		0
3				102	16		0	12		23	0	0
4				59			0	12	97	23		0
5	0	0		44	31	24				23		0
6	0	0		41	11	24	12				0	13
7	0		0	15	23	13	22				0	11
8	0	0	0	0	0	15	27			0	0	
9	0		0	0	0	0	51			0	0	
10	0	23	0	12	0	0	39			0	0	
11	0		0	12		0	35		11	0	0	0
12	0			13		0	44		11			12
13	23	13	0			11	53		11		0	0
14	23	12			0	11	39		11		13	
15	23		0			27			11		12	
16	24	0			23	29				0	12	0
17	28	0			11			38			14	
18	27		0	23	11	28	0		11		0	0
19	26	0		13	23	25	0		11	0	0	0
20		23		26			0		11		0	13
21	72	26	0	43			0		11		0	27
22	60	29					0		11	12	0	19
23	49		12	25	51		0	49	12	11		22
24	30	11	13	44	20		0		12	22	0	
25	44	22	12	36	20	16	0		23	22		17
26		11				20	0		39	23		
27			43	25		18	0		36	23	12	
28	27	55	42				0	15	37	23		
29			44				0		35		11	
30	22		45		0	11	0			22	0	
31			49		0		0			11		
Monthly mean	21.3	14.8	19.3	33.1	14.9	15.4	12.7	21.3	26.4	13.7	3.5	7.4
Yearly mean	16.7											
Days recorded	23	17	19	20	18	20	27	7	20	19	21	18
Total days recorded	229											

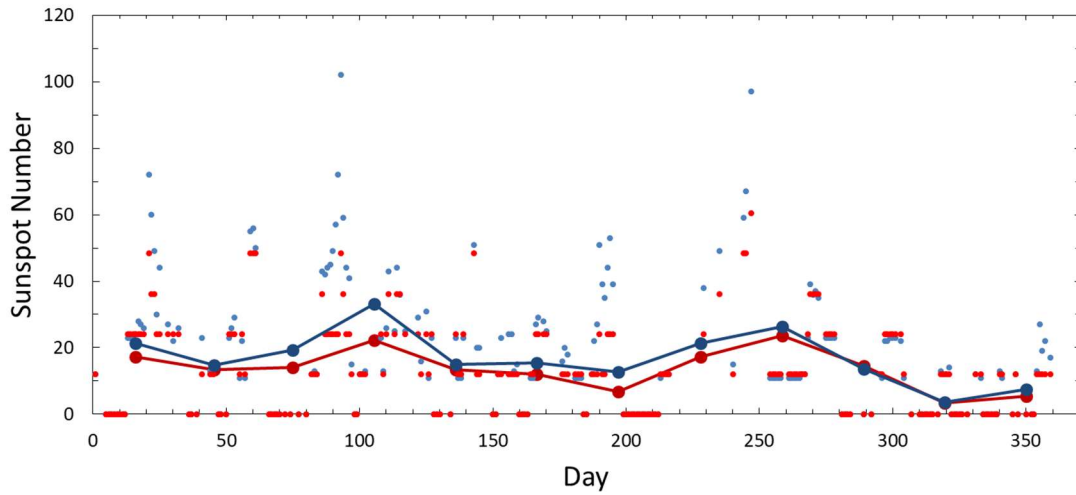


Figure 1. Daily (little dots) and monthly (big dots and lines)  $SN_{UEx}$  (blue) and  $GSN_{UEx}$  (red) values in 2017.

### Relationship with the reference sunspot index

We have compared  $SN_{UEx}$  with the sunspot number ( $S_N$ , version 2.0), provided by the World Data Center SILSO, Royal Observatory of Belgium, Brussels (see Figure 2).

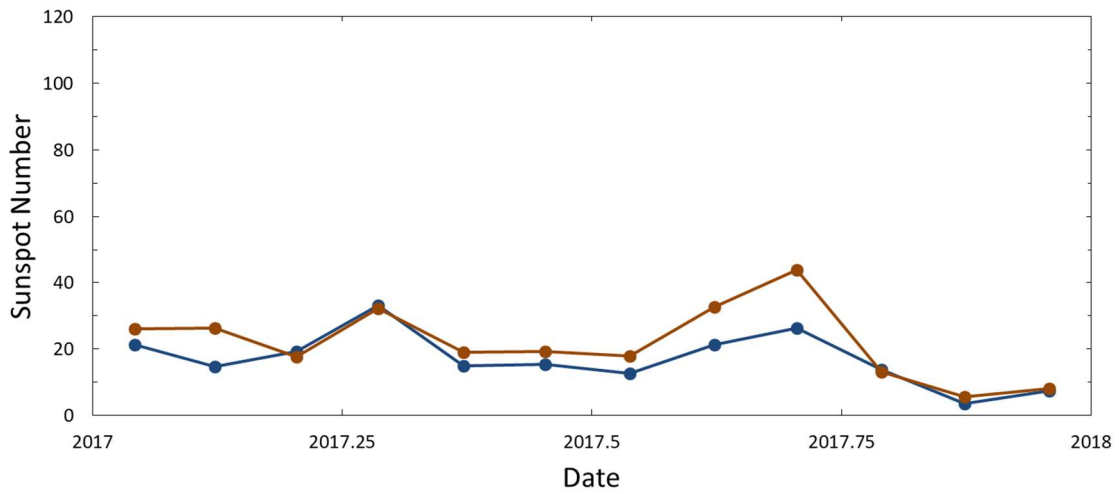


Figure 2. Monthly  $SN_{UEx}$  (blue) and  $S_N$  (brown) values in 2017.

Figure 3 shows a scatter plot of daily  $SN_{UEx}$  versus  $S_N$  values for those values corresponding to 2017. Here is the linear fit equation:

$$SN_{UEx} = (0.88 \pm 0.02) S_N + (-1.66 \pm 0.53) \quad (r = 0.955; p\text{-value} < 0.001)$$

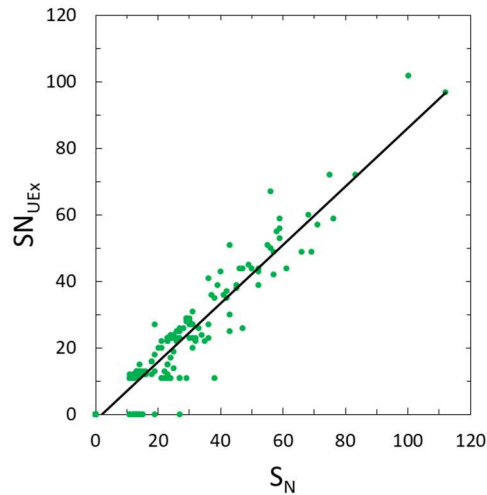


Figure 3. Scatter plot of daily  $SN_{UEx}$  versus  $S_N$  values in 2017.

### Acknowledgements

We appreciate the assistance provided by those students who have collaborated in our sunspot counting program. A. J. P. Aparicio thanks the Ministerio de Educación, Cultura y Deporte for the award of a FPU grant. J. M. Vaquero have benefited from the participation in ISSI workshops. This work was partly funded by FEDER-Junta de Extremadura (Research Group Grant GR15137 and project IB16127) and from the Ministerio de Economía y Competitividad of the Spanish Government (AYA2014-57556-P and CGL2017-87917-P).

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