# Solar activity from detailed sunspot database An alternative measure

#### Judit Muraközy

Debrecen Heliophysical Observatory, Konkoly Thege Miklós Astronomical Institute, Research Centre for Astronomy and Earth Sciences, Hungarian Academy of Sciences

> 10th Workshop, Primorsko, Bulgaria June 06, 2018

#### Outlook

Measure of the solar activity Weaknesses of the Sunspot number Proposed alternative measure Summary

# Abstract

To reconsider the physical meaning of the sunspot number we have to remember that there are different physical mechanisms which govern its two components: the number of observed sunspot groups (denoted by g) and the number of all observed spots (denoted by s). These are one of the reasons of the ambiguity of the sunspot number. To eliminate this ambiguity we need to take into account not only the sunspot sizes but the aspects of observability as well.

This talk will suggest a new activity index which can be given by using detailed sunspot data. The mentioned index is the amount of emerged magnetic flux which can be calculated by using the sunspot area dataset, the only long-term proxy measure. It can be calibrated to the magnetic flux.

The detailed Debrecen databases provide the opportunity to calculate the suggested sunspot index.

#### Outlook

Measure of the solar activity Weaknesses of the Sunspot number Proposed alternative measure Summary

# Outlook

- Measure of the solar activity
  - Past
  - Recent
- Its weaknesses
- Proposed alternative measure
  - Detailed sunspot database
  - Method
- Summary

Outlook

Past Recent

## Wolf number – Relative sunspot number



Introduced by R. Wolf 1848 at the Zurich Observatory

$$R_Z = k \cdot (10g + s) \tag{1}$$

where k: constans for each observatory g: number of sunspot groups s: number of sunspots

Past Recent

## International Sunspot Number

Now International Sunspot Number by Sunspot Index and Long-term Solar Observations (SILSO) team at the Royal Observatory, Brussels



SILSO graphics (http://sidc.be/silso) Royal Observatory of Belgium 2018 May 1

Observability Method Physical meaning of the Wolf definition

# Problems with the Sunspot number

The number of observed groups depend on

- Observational problem
  - the observability of sunpots (technical, seeing, center-limb variation of observability)
  - the sizes and distances from the central region
- Methodological problem
- Problem of the physical meaning of the Wolf definition

#### Area distribution

SDD

DPD



Observability

Physical meaning of the Wolf definition

Method

(Muraközy, J., Baranyi, T., Ludmány, A. 2016, Sol. Phys., 291, 2941-2950)

Observability Method Physical meaning of the Wolf definition

# ISSN – Wolf number (DPD; k=1)



8/20

Observability Method Physical meaning of the Wolf definition

# The real weight of a sunspot group



Observability Method Physical meaning of the Wolf definition

# Different mechanisms for g and s



(Muraközy, J., Baranyi, T., Ludmány, A. 2014, Sol. Phys., 289, 563-577)

Detailed sunspot database Method

# SOHO/MDI - Debrecen Sunspot Data - SDD

http://fenyi.solarobs.csfk.mta.hu/en/databases/SOHO/

- Published by Győri, L., Baranyi, T., Ludmány, A.
- Unique detailed sunspot catalogue
- Data for 1996–2010
- ► Contains area, location and magnetic polarity data for all individual sunspots
- Hourly resolution
- Freely available but the data policy: refer two publications

Summary

Detailed sunspot database Method

## SOHO/MDI - Debrecen Sunspot Data - SDD



Detailed sunspot database Method

# SOHO/MDI - Debrecen Sunspot Data - HTML presentation



Summary

Detailed sunspot database Method

# SOHO/MDI - Debrecen Sunspot Data - HTML presentation



Detailed sunspot database Method

# SOHO/MDI - Debrecen Sunspot Data - HTML presentation



Detailed sunspot database Method

# SOHO/MDI - Debrecen Sunspot Data - Data groups & spots

					-								t4 💷	4× 2018. máj. 31., cs 17.11/	.08 (Č)
III SUISPOCURAD	ase-SOF X	fenyi.solar	obs.csfk.mta.	×	fenyisolari	obs.csfk.ml	ta × +								
€⇒ G ®		U fenyls	olarobs.csfk.n	mta.hu/S	SDD/2001/2	0010611-07	0932/2001061	1-070932_94	189.html		-	···· 🐨 🛱 🔍 Keresés		* IN 🖬 🖬 »	· =
group Proj.	. U  Proj. W	/S Corr. U	Corr. W	/S	B	L  LCN	4 Pos. an	igle	r M	U MP	Dai	ta for the whole	group		
9489 1	10 64	17 64	37	70 18/	03 274.	14 24.6	0 307	.88 0.50	07 757.	4 293.5			0 1		
previous, or in	E IL CLOSETVO	tuon for the	i same grou	ip / baci	a to the st	Har use									
	an a	and a set	N N N N N N N N N N N N N N N N N N N												
	S040/40E 6/	11/2001 7:9:32	UT NEW SHEE												
spot Proj. U	SHOHEC 6	11/200 719182 Corr. U 30	UT NOW SHEE	B 17.94	L 277.59	LCM 28.05	Pos. angle   303.76	r 0.5402	MU 1582.1	MP 632.1	Dat	ta for all individ	ual spots	S	
spot Proj. U 1 51 2 11	300.400 6 Proj. WS	11/200 7:9:32 Corr. U 30 6	07 Now Set	B 17.94 17.53	L 277.59 276.92	LCM 28.05 27.37	Pos. angle 303.76 303.68	r 0.5402 0.5289	MU 1582.1 1814.7 718.0	MP 632-1 999999	Dat	ta for all individ	ual spots	S	
spot Proj. U 1 51 2 11 3 00 4 0	300.46( 6) Proj. WS 376 -1 9 5	11/2001 7:9132 Corr. U 30 6 0	Corr. WS	B 17.94 17.53 18.36 17.08	L 277.59 276.92 275.24 274.91	LCM 28.05 27.37 25.69 25.36	Pos. angle 303.76 303.68 306.63 304.80	r 0.5402 0.5289 0.5148 0.5006	MU 1582.1 1814.7 718.0 562.0	MP 632.1 999999 469.8 508.1	Dat	ta for all individ	ual spots	5	
spot Proj. U 1 51 2 11 3 0 4 0 5 0	5000000 6- Proj. WS 376 -1 9 5 7	Corr. U 30 6 0 0	07 Hire Sel8 Corr. WS 221 -1 5 3 4	B 17.94 17.53 18.36 17.08 18.90	L 277.59 276.92 275.24 274.91 274.96	LCM 28.05 27.37 25.69 25.36 25.41	Pos. angle 303.76 303.68 306.63 304.80 307.79	r 0.5402 0.5289 0.5148 0.5006 0.5158	MU 1582.1 1814.7 718.0 562.0 -811.0	MP 632.1 999999 469.8 508.1 -603.5	Dai	ta for all individ • spot number	ual spots	S	
spot Proj. U 1 51 2 11 3 0 4 0 5 0 6 4	376 41 9 5 7 23	Corr. U 30 6 0 0 3 3	07 How Set	B 17.94 17.53 18.36 17.08 18.90 16.71	L 277.59 276.92 275.24 274.91 274.96 274.44	LCM 28.05 27.37 25.69 25.36 25.41 24.90	Pos. angle 303.76 303.68 306.63 304.80 307.79 304.61	r 0.5402 0.5289 0.5148 0.5006 0.5158 0.4919	MU 1582.1 1814.7 718.0 562.0 -811.0 1074.5	MP 632.1 999999 469.8 508.1 -603.5 828.2	Dat	ta for all individ spot number	ual spots	S	
spot Proj. U 1 51 2 11 3 0 4 0 5 0 6 4 7 2	376 41 9 5 7 23 6 6	Corr. U 30 6 0 0 3 1	UT HOW Set	B 17.94 17.53 18.36 17.08 18.90 16.71 17.00	L 277.59 276.92 275.24 274.91 274.96 274.44 274.39	LCM 28.05 27.37 25.69 25.36 25.41 24.90 24.85	Pos. angle 303.76 303.68 306.63 304.80 307.79 304.61 305.17	r 0.5402 0.5289 0.5148 0.5006 0.5158 0.4919 0.4935	MU 1582.1 1814.7 718.0 562.0 -811.0 1074.5 1127.2	MP 632.1 999999 469.8 508.1 -603.5 828.2 999999	Dat	ta for all individ • spot number • projected are	ual spots a of umb	s ora and th	ne whole s
spot Proj. U 1 51 2 11 3 0 4 0 5 0 6 4 7 2 8 0 9 0	900000 6- Proj. WS 376 4 9 5 7 233 -6 9 5 7 23 -6 9 5	Corr. U 30 6 0 0 3 1 1 0	Corr. WS 221 -1 5 3 4 13 -6 5 2	B 17.94 17.53 18.36 17.08 18.90 16.71 17.00 17.46 16.14	L 277.59 276.92 275.24 274.91 274.96 274.44 274.39 273.387 273.387	LCM 28.05 27.37 25.69 25.36 25.41 24.90 24.85 24.32 24.32 24.32	Pos. angle 303.76 303.68 306.63 304.80 307.79 304.61 305.17 306.50 204.74	r 0.5402 0.5289 0.5148 0.5006 0.5158 0.4919 0.4935 0.4907 0.4935	MU 1582.1 1814.7 718.0 562.0 -811.0 1074.5 1127.2 891.0 -246.0	MP 632.1 999999 469.8 508.1 -603.5 828.2 999999 616.4 -245.9	Dat	ta for all individ spot number projected are	ual spots a of umb	s ora and th	ne whole s
spot Proj. U 1 51 2 11 3 0 4 0 5 0 6 4 7 2 8 0 9 0 10 0	900000 6- Proj. WS 376 	Corr. U 30 6 0 0 3 1 0 0 0 0 0 0 0 0 0 0 0 0 0	Corr. WS 221 -1 5 3 4 13 -6 5 3 3	B 17.94 17.53 18.36 17.08 18.90 16.71 17.00 17.46 16.14 16.56	L 277.59 276.92 275.24 274.91 274.96 274.44 274.39 273.87 273.33 273.13	LCM 28.05 27.37 25.69 25.36 25.41 24.90 24.85 24.32 23.78 23.56	Pos. angle 303.76 303.68 306.63 304.80 307.79 304.61 305.17 306.50 304.74 305.72	r 0.5402 0.5289 0.5148 0.5006 0.5158 0.4919 0.4935 0.4907 0.4733 0.4733	MU 1582.1 1814.7 718.0 562.0 -811.0 1074.5 1127.2 891.0 -346.0 -693.0	MP 632.1 999999 469.8 508.1 -603.5 828.2 999999 616.4 -345.9 -582.1	Dat	ta for all individ • spot number • projected are • corrected are	ual spots a of umb	s ora and th	ne whole s
spot Proj. U 1 51 2 11 3 0 4 0 5 0 6 4 7 2 8 0 9 0 10 0 11 0	900000 6- Proj. WS 3766 -1 9 5 7 23 -6 9 5 6 5 6 5 6 5 5 5 5	Corr. U 30 6 0 0 31 1 0 0 0 0 0 0 0 0 0 0 0 0 0	01 How Set	B 17.94 17.53 18.36 17.08 18.90 16.71 17.00 17.46 16.14 16.56 17.91	L 277.59 276.92 275.24 274.91 274.96 274.44 274.39 273.87 273.33 273.11 273.29	LCM 28.05 27.37 25.69 25.36 25.41 24.90 24.85 24.32 23.78 23.78 23.75	Pos. angle 303.76 303.68 306.63 307.79 304.61 305.17 306.50 304.74 305.72 307.90	r 0.5402 0.5289 0.5148 0.5006 0.5158 0.4919 0.4935 0.4907 0.4733 0.4739	MU 1582.1 1814.7 718.0 562.0 -811.0 1074.5 1127.2 891.0 -346.0 -693.0 680.0	MP 632.1 999999 469.8 508.1 -603.5 828.2 999999 616.4 -345.9 -582.1 591.1	Dat	ta for all individ • spot number • projected are • corrected are	ual spots a of umb a of umb	s ora and th ora and th	ne whole s
spot Proj. U 1 51 2 11 3 00 4 0 5 0 6 4 7 2 8 0 9 0 10 0 11 0 12 0 1	500.001 6- Proj. WS 376 -1 9 5 7 223 -6 9 5 6 9 5 5 5 5	Corr. U 30 6 0 0 0 0 0 0 0 0 0 0 0 0 0	01 Here Set	B 17.94 17.53 18.36 17.08 18.90 16.71 17.00 17.46 16.14 16.56 17.91 16.64	L 277.59 276.92 275.24 274.91 274.96 274.94 273.87 273.33 273.31 273.21 273.29 271.20	LCM 28.05 27.37 25.69 25.36 25.41 24.90 24.85 24.32 23.78 23.75 23.75 23.75	Pos. angle 303.76 303.68 306.63 304.80 307.79 304.61 305.17 306.50 304.74 305.72 304.74 305.72 307.90 308.07 308.07 308.07 308.07 308.07 309.08 309.09 30	r 0.5402 0.5289 0.5148 0.5006 0.5158 0.4919 0.4935 0.4907 0.4733 0.4739 0.4739 0.4876 0.4809	MU 1582.1 1814.7 718.0 562.0 -811.0 1074.5 1127.2 891.0 -346.0 -693.0 688.0 -693.0 -860.0	MP 632.1 999999 508.1 469.8 508.1 4603.5 828.2 999999 616.4 -345.9 -582.1 591.1 591.1 591.1 4615.3	Dat •	ta for all individ spot number projected are corrected are	ual spots a of umb a of umb	s ora and th ora and th	ne whole s
spot Proj. U 1 51 2 11 3 0 4 0 5 0 6 4 7 2 8 0 9 0 10 0 11 0 12 0 13 9	30040 6 Proj. WS 3766 -1 9 9 5 7 7 233 -6 9 9 5 -6 6 -6 5 5 -5 5 -5 5 -1 9	Corr. U 30 6 0 0 3 1 0 0 0 0 0 0 0 0 0 0 0 0 0	01 Here see	B 17.94 17.53 18.36 17.08 18.90 16.71 17.00 17.46 16.14 16.56 17.91 16.64 19.30	L 277.59 276.92 275.24 274.91 274.96 274.94 274.39 273.87 273.33 273.31 273.29 273.29 271.20 270.20	LCM 28.05 27.37 25.69 25.36 25.41 24.90 24.85 24.32 23.78 23.75 23.75 23.75 21.65 20.65	Pos. angle 303.76 303.68 306.63 304.80 305.17 306.50 304.74 305.72 307.79 305.72 307.90 313.96	r 0.5402 0.5289 0.5148 0.5006 0.5158 0.4919 0.4935 0.4937 0.4937 0.4937 0.4937 0.4937 0.4937 0.4937 0.4939 0.4876 0.4509 0.4504	MU 1582.1 1814.7 718.0 562.0 -811.0 1074.5 1127.2 891.0 -346.0 -693.0 680.0 906.0	MP 632.1 999999 469.8 508.1 603.5 828.2 999999 616.4 345.9 -582.1 591.1 615.3 618.4	Dat	ta for all individ • spot number • projected are • corrected are • position data	ual spots a of umb a of umb (B. L. dis	s ora and th ora and th st. from (	ne whole s ne whole s CM. pos.
spot Proj. U 1 51 2 11 3 00 4 00 6 4 7 2 8 00 9 00 10 0 11 0 12 0 13 9 14 7	5000000 64 Proj. WS 3776 41 1 99 55 77 233 46 99 55 66 55 55 1 99 28	Corr. U 30 6 0 0 3 1 1 0 0 0 0 0 0 0 0 0 4	Corr. WS 221 -1 5 3 4 4 13 -6 5 3 3 3 3 3 3 11 16	B 17.94 17.53 18.36 17.08 18.90 16.71 17.00 17.46 16.16 16.56 17.91 16.64 19.30 16.49	L 277.59 276.92 275.24 274.91 274.96 274.44 274.39 273.87 273.87 273.33 273.11 273.29 271.20 270.20 270.20 270.20	LCM 28.05 27.37 25.69 25.36 25.41 24.90 24.85 24.32 23.78 23.56 23.75 21.65 20.65 20.09	Pos. angle 303.76 303.68 306.63 304.80 307.79 304.61 305.17 306.50 304.74 305.72 307.90 308.07 313.96 309.77	r 0.5402 0.5289 0.5148 0.5006 0.5158 0.4919 0.4935 0.4907 0.4733 0.4739 0.4876 0.4509 0.4504	MU 1582.1 1814.7 718.0 562.0 -811.0 1074.5 1127.2 891.0 -346.0 -693.0 680.0 906.0 -860.0 906.0	MP 632.1 999999 469.8 508.1 -603.5 828.2 999999 616.4 -345.9 -582.1 591.1 -615.3 618.4 -497.3	Dai	ta for all individ spot number projected are corrected are position data	ual spots a of umb a of umb (B, L, dis	s ora and th ora and th st. from (	ne whole s ne whole s CM, pos.
spot Proj. U 1 51 2 11 3 0 4 0 5 0 6 4 7 2 8 0 9 0 10 0 11 0 12 0 13 9 14 7 15 0 0	30040 6 Proj. WS 376 	Corr. U 30 6 0 0 0 0 0 0 0 0 0 0 0 0 0	Corr. WS 221 -1 5 3 4 4 13 -6 -6 -6 -5 3 3 3 3 3 11 11 16 6 -3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3	B 17.94 17.53 18.36 17.08 18.90 16.71 17.00 17.46 16.16 16.56 17.91 16.64 19.30 16.49 18.14	L 277.59 276.92 275.24 274.91 274.46 274.49 273.87 273.87 273.33 273.13 273.12 273.12 273.12 273.29 271.20 270.20 269.64 268.72	LCM 28.05 27.37 25.69 25.36 25.41 24.90 24.85 24.32 23.76 23.75 21.65 20.09 19.18	Pos. angle 303.76 303.68 306.63 307.79 304.80 305.17 306.50 304.74 305.72 306.57 308.07 313.96 309.77 314.02	r 0.5402 0.5289 0.5148 0.5006 0.4919 0.4935 0.4907 0.4935 0.4907 0.4739 0.4739 0.4739 0.4759 0.4876 0.4300 0.4300	MU 1582.1 1814.7 7180.0 -811.0 1074.5 1127.2 891.0 -346.0 -693.0 680.0 -860.0 906.0 906.0 906.0 906.0	MP 632.1 999999 469.8 508.1 603.5 828.2 999999 616.4 -345.9 616.4 -345.9 -582.1 616.4 -591.1 -615.3 618.4 97.3 4479.0	Dat	ta for all individ spot number projected are corrected are position data angle)	ual spots a of umb a of umb (B, L, dis	s ora and th ora and th st. from (	ne whole s ne whole s CM, pos.
spot Proj. U 1 51 2 11 3 0 4 0 5 0 6 4 7 2 8 0 9 0 10 0 11 0 12 0 13 9 14 7 13 9 14 7 15 0 16 4 15 0 16 4 15 0 16 0 17 0 18 0 19 0 10 0 10 10 0 10 0 1	5000000 6 Proj. WS 3776 -4 9 9 5 5 - 6 - 6 - 5 - 5 - 19 9 - 233 - - 6 - - - - - - - - - - - - -	Corr. U 30 6 0 0 0 0 0 0 0 0 0 0 0 0 0	01 Here see	B 17.94 17.53 18.36 17.08 18.90 16.71 17.00 17.46 16.14 16.56 17.91 16.64 19.30 16.49 18.14 19.69 18.14	L 277.59 276.92 275.24 274.91 274.49 273.87 273.87 273.87 273.33 273.11 273.29 271.20 270.20 269.64 268.72 268.64	LCM 28.05 27.37 25.69 25.36 25.41 24.90 24.85 24.32 23.56 23.78 23.58 23.75 21.65 20.65 20.09 19.18 19.10	Pos. angle 303.76 303.68 306.63 304.80 307.79 304.61 305.77 304.74 305.70 304.74 305.72 304.74 305.70 308.07 313.96 313.96 314.02 316.72	r 0.5402 0.5289 0.5148 0.5006 0.4919 0.4935 0.4907 0.4733 0.4739 0.4739 0.4760 0.4509 0.4644 0.4360 0.4333 0.4913	MU 1582.1 1814.7 718.0 562.0 -811.0 1074.5 1127.2 891.0 -346.0 -693.0 680.0 -860.0 906.0 -746.6 -574.0 866.6	MP 632.1 999999 6469.8 508.1 508.1 508.1 828.2 999999 616.4 532.1 591.1 591.1 615.3 618.4 415.3 618.4 4497.3 618.4 4497.0 649.5	Dai	ta for all individ spot number projected are corrected are position data angle)	ual spots a of umb a of umb (B, L, dis	s ora and th ora and th st. from (	ne whole s ne whole s CM, pos.
spot         Proj. U           1         51           2         11           3         0           4         00           5         0           6         4           7         2           8         0           9         0           11         0           12         0           13         9           14         7           15         0           16         4           17         4	5000000 6 Proj. WS 3776 41 9 5 7 7 233 -6 9 9 5 -6 -6 -6 -6 -5 -5 -6 -6 -6 -6 -6 -7 -7 -7 -7 -7 -7 -7 -7 -7 -7	Corr. U 30 6 0 0 0 0 0 0 0 0 0 0 0 0 0	Corr. WS 221 -1 -1 -3 -3 -6 -5 -3 -3 -6 -5 -3 -3 -3 -3 -3 -3 -3 -3 -3 -3 -3 -3 -3	B 17.94 17.53 18.36 17.08 18.90 16.71 17.00 17.46 16.14 16.64 19.30 16.64 19.30 16.49 18.14 19.68 18.60	L 277.59 276.92 275.24 274.91 274.96 274.44 274.39 273.87 273.87 273.87 273.87 273.87 273.80 270.20 269.64 268.79 268.64 268.29	LCM 28.05 27.37 25.69 25.36 25.41 24.90 24.85 24.32 23.78 23.56 23.55 21.65 20.05 20.09 19.18 19.10 18.75 19.21 20.25 20.25 20.25 20.25 20.25 20.25 20.25 20.25 20.25 20.25 20.25 20.25 20.55 20.0	Pos. angle 303.76 303.68 306.63 304.80 307.79 305.17 305.17 305.17 304.74 305.72 307.90 304.74 305.72 307.90 304.74 305.72 307.90 304.74 305.72 307.90 305.71 305.72 307.90 305.72 30	r 0.5402 0.5289 0.5148 0.5006 0.5158 0.4919 0.4935 0.4935 0.4733 0.4739 0.4876 0.4509 0.4644 0.4304 0.4360 0.4533 0.4359 0.4235	MU 1582.1 1814.7 718.0 562.0 -811.0 1074.2 891.0 -346.0 -693.0 688.0 906.0 -746.6 -574.0 866.6 -831.4 932.8	MP 632.1 999999 669.8 508.1 4003.5 8282 8282 999999 616.4 -582.1 591.1 591.1 591.1 582.1 591.1 618.4 497.3 479.0 618.4 497.3 479.0 649.5 649.5	Dat	ta for all individ spot number projected are corrected are position data angle)	ual spots a of umb a of umb (B, L, dis	s ora and th ora and th st. from (	ne whole si ne whole si CM, pos.
spot         Proj. U           1         51           2         111           3         0           4         0           5         0           6         4           7         2           8         0           10         0           11         0           12         0           13         9           14         7           15         0           16         4           17         4           18         3           19         0	5000000 60 Proj. WS 3776 3777 3776 37	Corr. U 30 6 0 0 0 0 0 0 0 0 0 0 0 0 0	Corr. WS 221 -1 5 -3 -4 4 4 -6 -5 -5 -3 -3 -3 -6 -5 -5 -5 -5 -5 -5 -5 -5 -5 -5	B 17.94 17.53 18.36 18.90 16.71 17.06 16.14 16.56 17.91 16.64 19.30 16.49 18.14 19.68 18.60 17.85	L 277.59 276.92 275.24 274.91 274.96 274.96 273.33 273.11 273.29 273.20 270.20 269.64 268.72 268.64 268.29 267.86	LCM 28.05 27.37 25.69 25.36 25.41 24.90 24.85 24.32 23.78 23.56 23.75 20.65 20.09 19.10 19.10 19.10 18.75 18.31	Pos. angle 303.76 303.68 306.63 304.80 307.90 304.61 305.72 306.50 304.74 305.72 308.07 313.96 309.77 314.02 315.43 314.78 315.78 315.78 315.78 315.78 315.78 315.78 315.78 315.78 315.78 315.78 315.78 315.78 31	r 0.5402 0.5289 0.5148 0.5006 0.5158 0.4919 0.4935 0.4907 0.4733 0.4739 0.4739 0.4739 0.476 0.4509 0.4236 0.4304 0.4304 0.4336 0.4359 0.4325 0.4232 0.4232	MU 1582.1 1814.7 718.0 562.0 -811.0 1074.5 1127.2 891.0 -693.0 -693.0 -693.0 -693.0 -693.0 -693.0 -860.0 -860.0 -906.0 -746.6 -574.6 -5	MP 632.1 999999 508.1 603.5 828.2 999999 616.4 582.1 592.1 592.1 592.1 592.1 592.1 592.1 592.1 592.1 592.1 999999 616.5 592.1 999999 616.5 592.1 999999 616.5 592.1 999999 616.5 592.1 9999999 616.5 592.1 9999999 616.5 592.1 9999999 616.5 592.1 9999999 616.5 592.1 9999999 616.5 592.1 9999999 616.5 592.1 592	Dai	ta for all individ spot number projected are corrected are position data angle) magnetic data	ual spots a of umk a of umk (B, L, dis a for uml	s ora and th ora and th st. from ( bra and t	ne whole sp ne whole sp CM, pos. he whole
spot         Proj. U           1         51           2         11           3         00           4         0           5         00           6         4           7         22           9         00           13         00           13         0           14         7           15         0           16         44           17         41           18         33           19         0           74         0	5000000 6 Proj. WS 3776 41 9 9 5 7 7 223 5 5 5 6 6 5 5 5 5 5 1 28 5 1 28 5 1 28 5 1 28 5 1 28 5 1 1 1 1 1 1 1 1 1 1 1 1 1	Corr. U 30 6 0 0 0 0 0 0 0 0 0 0 0 0 0	Corr. WS 221 -1 5 3 4 4 4 13 -6 5 5 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3	B 17.94 17.53 18.36 18.36 18.30 16.71 17.06 16.44 19.30 16.49 18.14 19.68 18.64 17.85 17.40 18.14 19.68 18.64 17.85 17.40 17.4	L 277.59 276.92 274.92 274.91 274.96 274.33 273.87 273.87 273.13 273.11 273.29 271.20 270.20 269.64 268.29 268.64 268.29 267.86 267.86 267.81	LCM 28.05 27.37 25.69 25.36 25.41 24.90 24.85 24.32 23.78 23.56 23.75 20.65 20.09 19.10 19.10 19.10 19.51 18.31 18.27 12.65	Pos. angle 303.76 303.68 306.63 304.80 307.79 306.50 304.74 305.72 306.50 304.74 305.72 307.90 308.07 313.96 309.77 314.02 316.72 314.78 314.78 314.78 314.04 316.42 316.78 31	r 0.5402 0.5289 0.5148 0.5006 0.5158 0.4919 0.4935 0.4907 0.4733 0.4739 0.4739 0.4739 0.4760 0.4509 0.4360 0.45430 0.45430 0.4515 0.4515 0.4516 0.4535 0.4536 0.4566 0	MU 1582.1 1814.7 718.0 562.0 4811.0 1074.5 1127.2 891.0 -693.0 -693.0 6906.0 -746.6 -5740.6 -5740.6 -5740.6 -631.4 -932.8 -562.0 566.0 576	MP 632.1 999999 469.8 508.1 4603.5 828.2 9999999 616.4 -345.3 616.4 -582.1 591.1 618.4 497.3 618.4 497.0 649.5 604.7 -740.9 6443.5	Dai	ta for all individ spot number projected are corrected are position data angle) magnetic data	ual spots a of umb a of umb (B, L, dis a for uml	s ora and th ora and th st. from ( bra and t	ne whole s ne whole s CM, pos. he whole

June 06, 2018 / Primorsko (Bulgaria)

Muraközy, J.

Detailed sunspot database Method

# Total amount of emerged magnetic flux



(Muraközy, J., Baranyi, T., Ludmány, A. 2016, Sol. Phys., 291, 2941-2950)

Area - magnetic field relationship:

$$B = 0.04 \cdot logA + 0.07$$

#### The total magnetic flux:

$$TMF = K \left[ \sum f(A_i) A_i \right]_{LP}$$

Detailed sunspot database Method

# Dependence on the time of observations

#### Daily variation of the SSN



(Muraközy, J., Baranyi, T., Ludmány, A. 2016, Sol. Phys., 291, 2941-2950)

Detailed sunspot database Method

# Dependence on the time of observations



(Muraközy, J., Baranyi, T., Ludmány, A. 2016, Sol. Phys., 291, 2941-2950)

Detailed sunspot database Method

## Monthly variation of the TMF



(Muraközy, J., Baranyi, T., Ludmány, A. 2016, Sol. Phys., 291, 2941-2950)



- Wolf introduced the sunspot number in 1848
- The Wolf number has some weaknesses (observability, methodologicaly, meaning)
- The more reliable parameter to measure the solar activity is the TMF, which is not contaminated with non-activity measures
- The smaller sunspots have less impact on the TMF than on the Wolf number because of the quickly decreasing flux amount

# Thank you for your attention!