Preliminary Results of Statistical Study on the Solar Cycle 24

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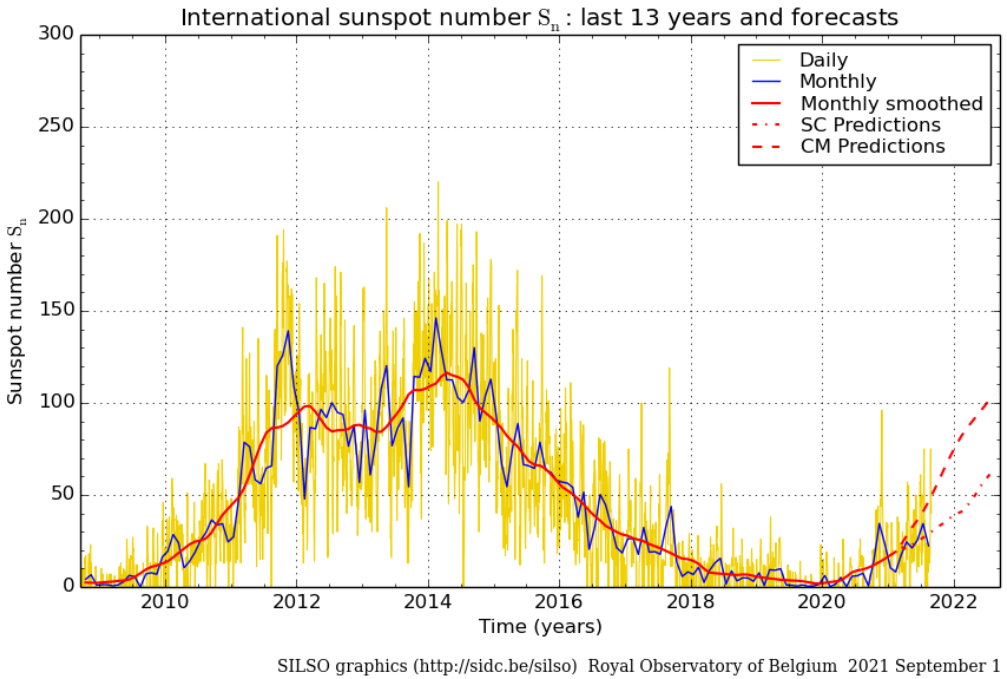
SOLAR CYCLE 24

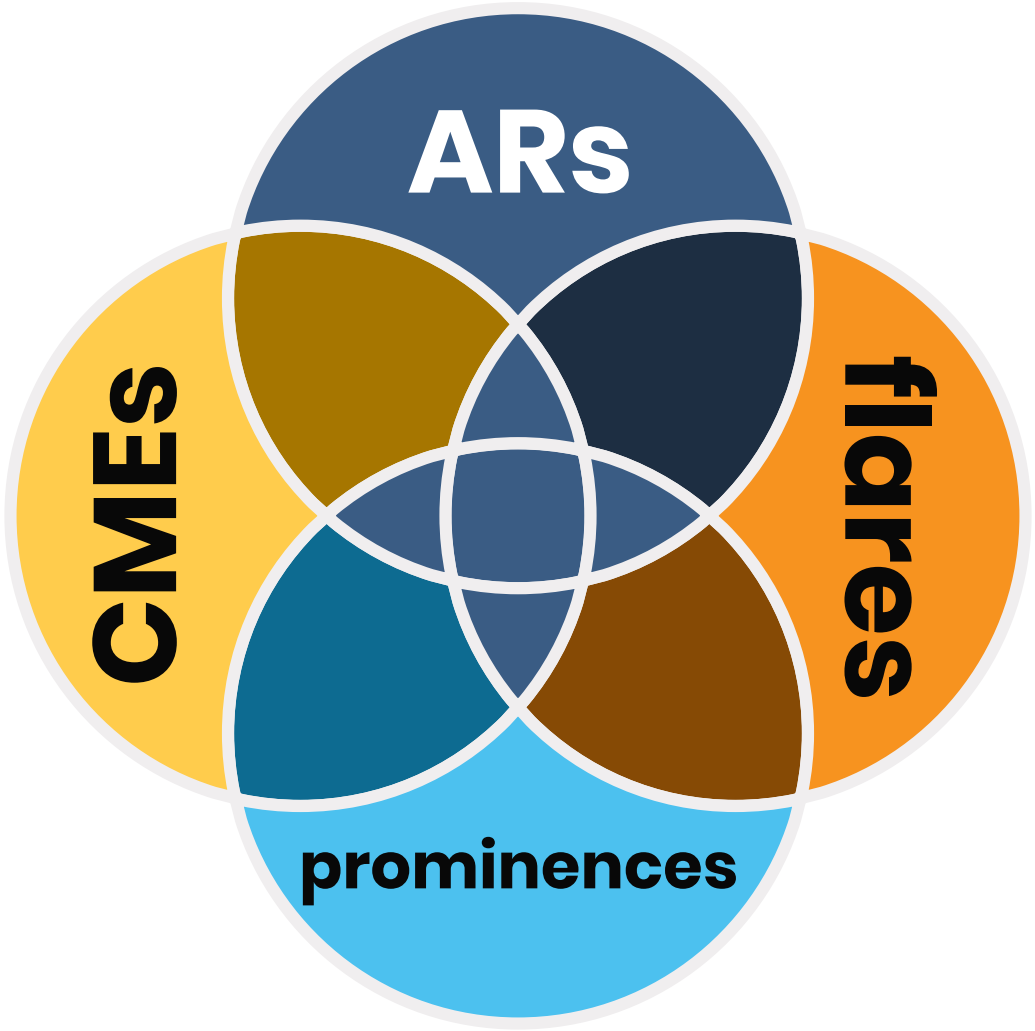
- Duration: December 2008 – December 2019[1]
- Maximum: April 2014



Number	Year	Month	SN	Year	Month	SN
1	1755	2	14	1761	6	144,1
2	1766	6	18,6	1769	9	193
3	1775	6	12	1778	5	264,2
4	1784	9	15,9	1788	2	235,3
5	1798	4	5,3	1805	2	82
6	1810	7	0	1816	5	81,2
7	1823	5	0,1	1829	11	119,2
8	1833	11	12,2	1837	3	244,9
9	1843	7	17,6	1848	2	219,9
10	1855	12	6	1860	2	186,2
11	1867	3	9,9	1870	8	234
12	1878	12	3,7	1883	12	124,4
13	1890	3	8,3	1894	1	146,5
14	1902	1	4,5	1906	2	107,1
15	1913	7	2,5	1917	8	175,7
16	1923	8	9,3	1928	4	130,2
17	1933	9	5,8	1937	4	198,6
18	1944	2	12,9	1947	5	218,7
19	1954	4	5,1	1958	3	285
20	1964	10	14,3	1968	11	156,6
21	1976	3	17,8	1979	12	232,9
22	1986	9	13,5	1989	11	212,5
23	1996	8	11,2	2001	11	180,3
24	2008	12	2,2	2014	4	116,4
25	2019	12	1,8			

[1] SILSO Database of Royal Observatory of Belgium, Brussels
http://sidc.oma.be/silso/cyclesminmax

SC24 CATALOG



DATA SOURCES

ARs | NOAA Space Weather Prediction Center[1]

flares | GOES soft X-ray flare listings[2]

+

CMEs | SOHO LASCO CME Catalog[3]

prominences | Kislovodsk Mountain Astronomical Station of the Pulkovo observatory[4]

= SC24 CATALOG

[1] https://swpc.noaa.gov/products/solar-region-summary

[2] https://hesperia.gsfc.nasa.gov/goes/goes_event_listings/

[3] http://cdaw.gsfc.nasa.gov/CME_list/

[4] http://en.solarstation.ru/sun-service/chromosphere/

ACTIVE REGIONS

- NOAA 11018 – 12753
- 2009 May 23 – 2019 December 26
- Total: 1735 ARs, 12106 records

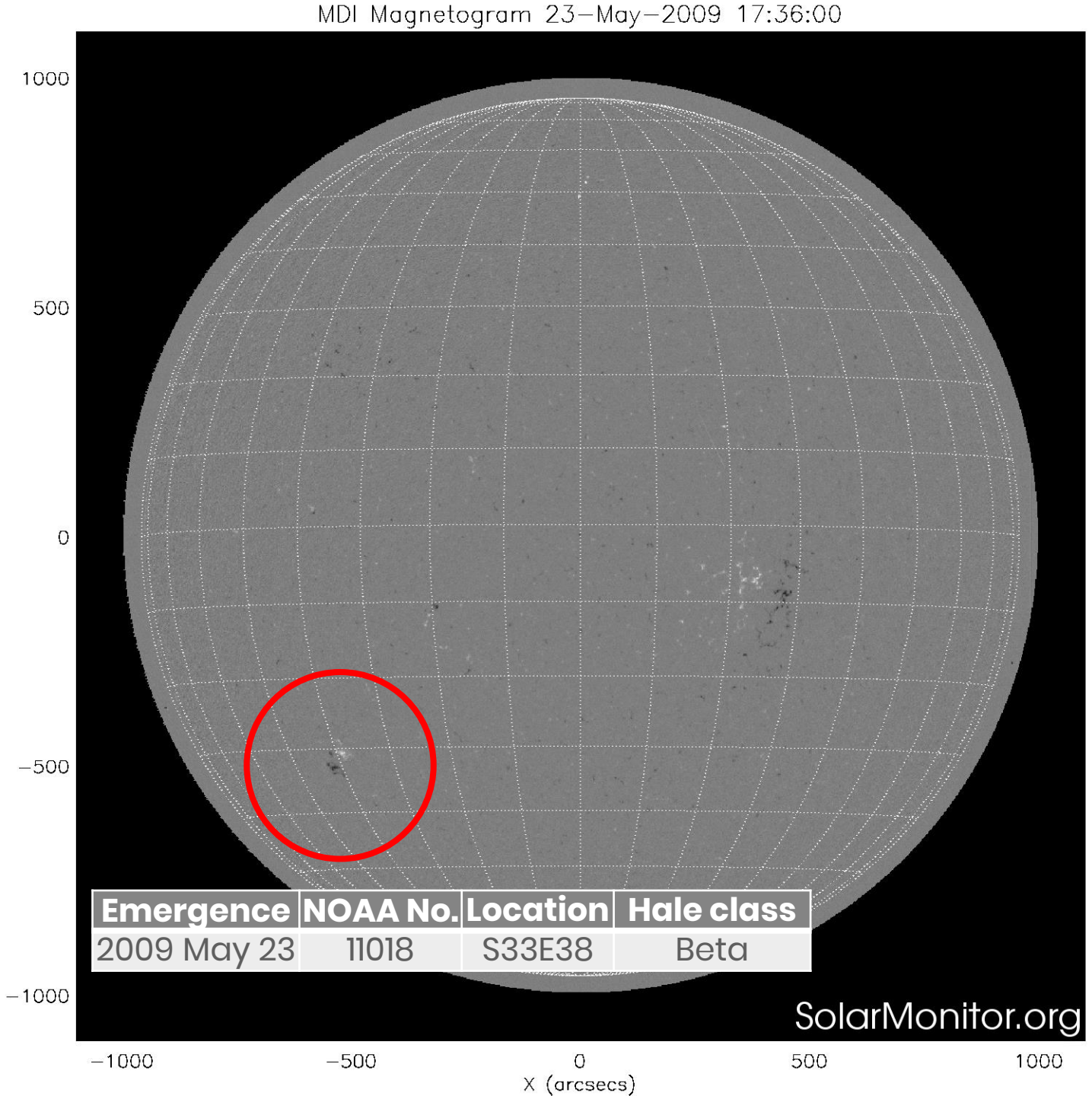
Beginning of SC24

11018 is the first AR with latitude > 30°

Dec 2008

May 2009

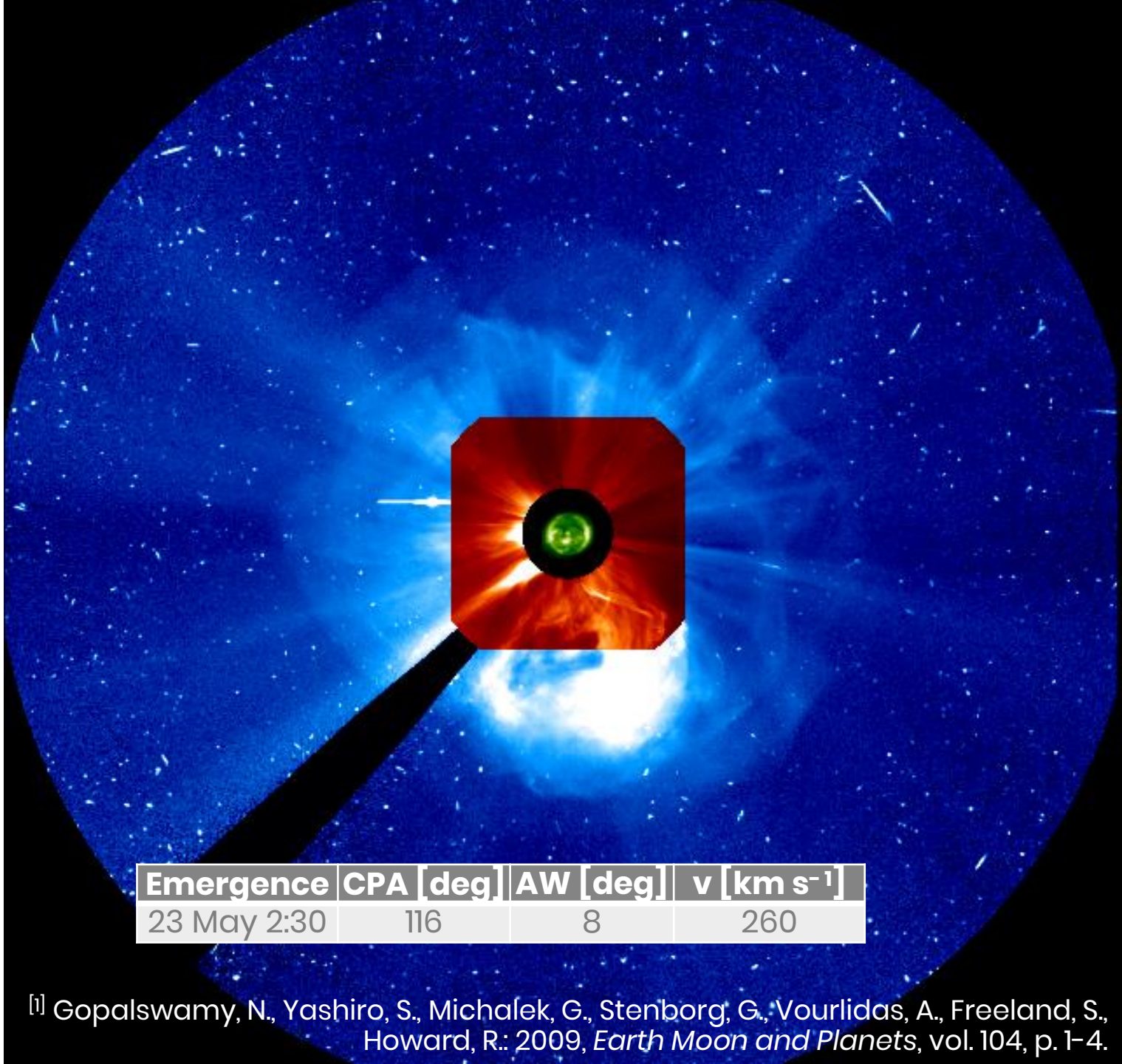
ARs 11010–11017



Emergence	NOAA No.	Location	Hale class
2009 May 23	11018	S33E38	Beta

CORONAL MASS EJECTIONS

- Detected by SOHO/LASCO coronagraphs[1]
- Total: 16178 CMEs
- AR coordinates -> CPA
- $|CPA_{AR} - CPA_{CME}| < 20°$

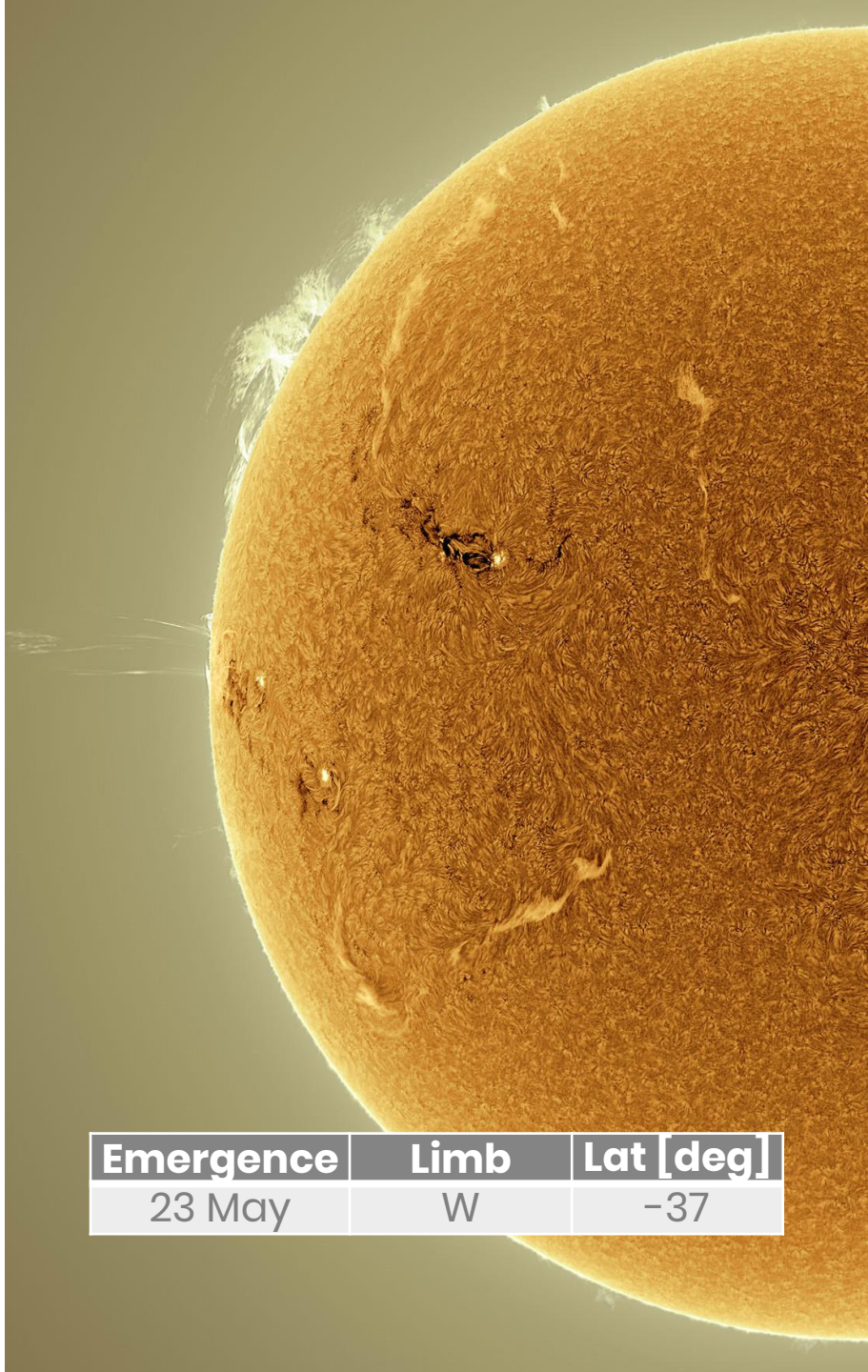


Emergence	CPA [deg]	AW [deg]	v [km s^{-1}]
23 May 2:30	116	8	260

[1] Gopalswamy, N., Yashiro, S., Michalek, G., Stenborg, G., Vourlidas, A., Freeland, S., Howard, R.: 2009, *Earth Moon and Planets*, vol. 104, p. 1-4.

PROMINENCES/ FILAMENTS

- Kislovodsk daily reports
- Hα observations 6563 Å
- Total: 21186 prominences & 45279 filaments
- $|Lat_{AR} - Lat_{Prom}| < 7°$



Emergence	Limb	Lat [deg]
23 May	W	-37

FLARES

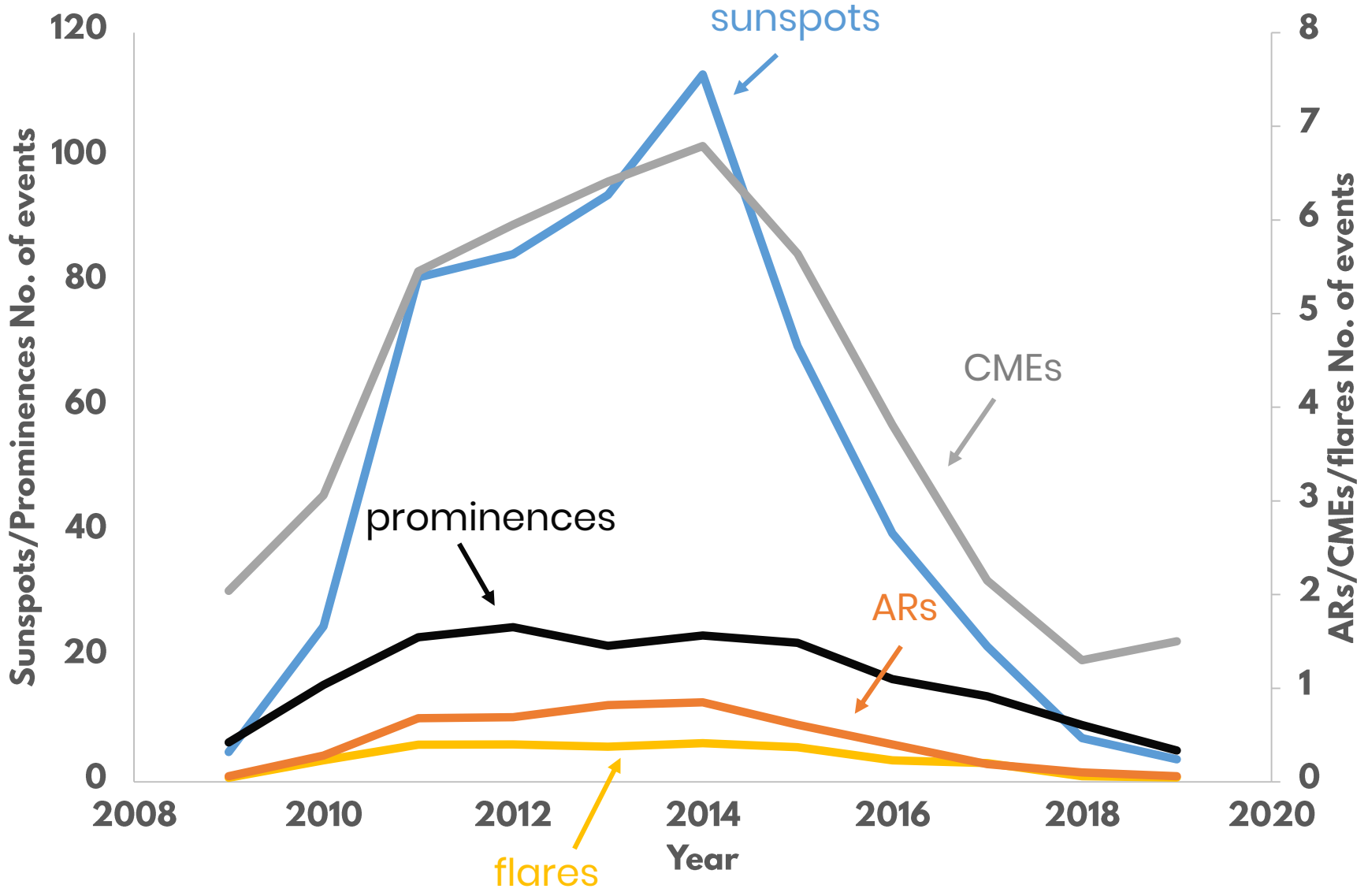
- GOES soft X-ray data
- Automated AR association
- Total: 15149 flares

Date	Time	Class
7 Mar	23:05	B1.3

STATISTICS

- Yearly mean total number of events (total daily number of events/365)

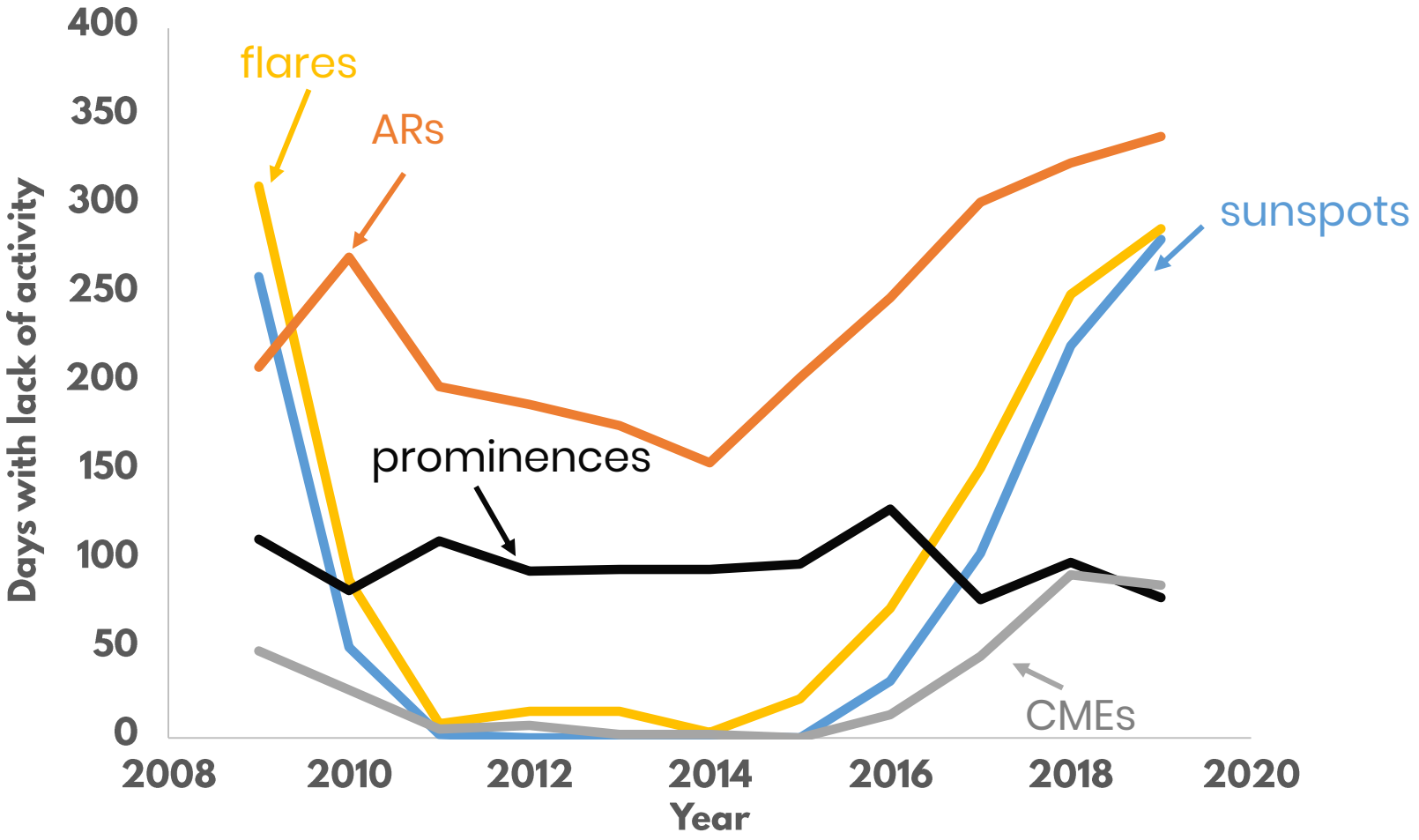
Event	Peak
Sunspots	2014
ARs	2014
Prominences	2012
Flares	2014
CMEs	2014



STATISTICS

- Days with lack of activity per year

Event	Min
Sunspots	2012-2015
ARs	2014
Prominences	2017
Flares	2014
CMEs	2015



STATISTICS

- Number of different types of CMEs/flares/prominences and ARs

		CMEs				Flares				Prominences			
		Number		%		Number		%		Number		%	
AR-related		1312		8.1		12589		83.1		947		1.4	
Non-AR-rel		14866		91.9		2560		16.9		65518		98.6	
Total		16178				15149				66465			
		-less	-productive	-rich (≥3)	Total	-less	-productive	-rich (≥3)	Total	-less	-productive	-rich (≥3)	Total
ARs	Number	976	759	138	1735	621	1114	769	1735	1089	646	58	1735
	%	56.3	43.7	8.0		35.8	64.2	44.3		62.8	37.2	3.3	
				18.2				69.0				9.0	

STATISTICS: ARs vs. CMEs

- More than **91% of CMEs cannot be associated with AR**
- Almost **44% of ARs produce CMEs**

		CMEs				Flares				Prominences			
		Number		%		Number		%		Number		%	
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STATISTICS: ARs vs. flares

- More than **83% of flares are AR-related**
- **64% of ARs produce at least 1 flare**
- Almost **70% of flare-productive ARs are flarerich** (source of more than 2 flares)

		CMEs				Flares				Prominences			
		Number		%		Number		%		Number		%	
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STATISTICS: ARs vs. prominences

- Almost **99% of prominences/filaments are not linked with AR**
- **63% of ARs are prominenceless**

		CMEs				Flares				Prominences			
		Number		%		Number		%		Number		%	
AR-related		1312		8.1		12589		83.1		947		1.4	
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DISCUSSION & GOALS

OPEN ACCESS

Solar research website
under construction

DISSEMINATION

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- Complete catalog of ARs and connected CMEs, flares, prominences/filaments for SC24
- Detailed statistical analyses
- Including additional data later

Thank you

МИНИСТЕРСТВО
НА ОБРАЗОВАНИЕТО
И НАУКАТА

BULGARIAN
SCIENCE
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