

The new SEP catalog from Wind/EPACT instrument



Rositsa Miteva

rmiteva@space.bas.bg

Space Research and Technology Institute–Bulgarian Academy of Sciences

Susan W. Samwel

National Research Institute of Astronomy and Geophysics, Helwan, Egypt

Marcus V. Costa-Duarte

*Institute of Astronomy, Geophysics and Atmospheric Sciences,
University of São Paulo, Brazil*

Dimitar Danov

Space Research and Technology Institute–Bulgarian Academy of Sciences

***First VarSITI General Symposium,
6–10 June 2016, Albena, Bulgaria***

Outline

I. Introduction and aim

II. Data analysis

III. The on-line catalog

IV. Preliminary scientific results

V. Future plans

I. Introduction: SEP catalogs

- **Contents**

++: comprehensive event list;

onset, peak, end time; peak intensity, fluence; overview plots; solar origin; additional information (p & e channels, emission signatures)

--: high threshold (weak events not reported);

erroneous onsets/peaks (also due to local acceleration at IP shocks);

saturation effects (large events not reported);

no comprehensive electron lists;

not regularly updated; etc.

- **Examples**

GOES list (p > 10 MeV) <http://umbra.nascom.nasa.gov/SEP/>

SEPServer list (p ~ 68 MeV) <http://server.sepserver.eu>

SEPPEM list (p ~ 10 MeV) http://dev.sepem.oma.be/help/event_ref.html

~25 MeV Cane et al. (2010)

I. Wind/EPACT data & analysis

Instrument:

Energetic Particles, Acceleration, Composition and Transport on Wind spacecraft
von Rosenvinge et al. (1995);
<http://epact2.gsfc.nasa.gov/>

Data source:

<http://cdaweb.gsfc.nasa.gov>

Time resolution: 92-sec

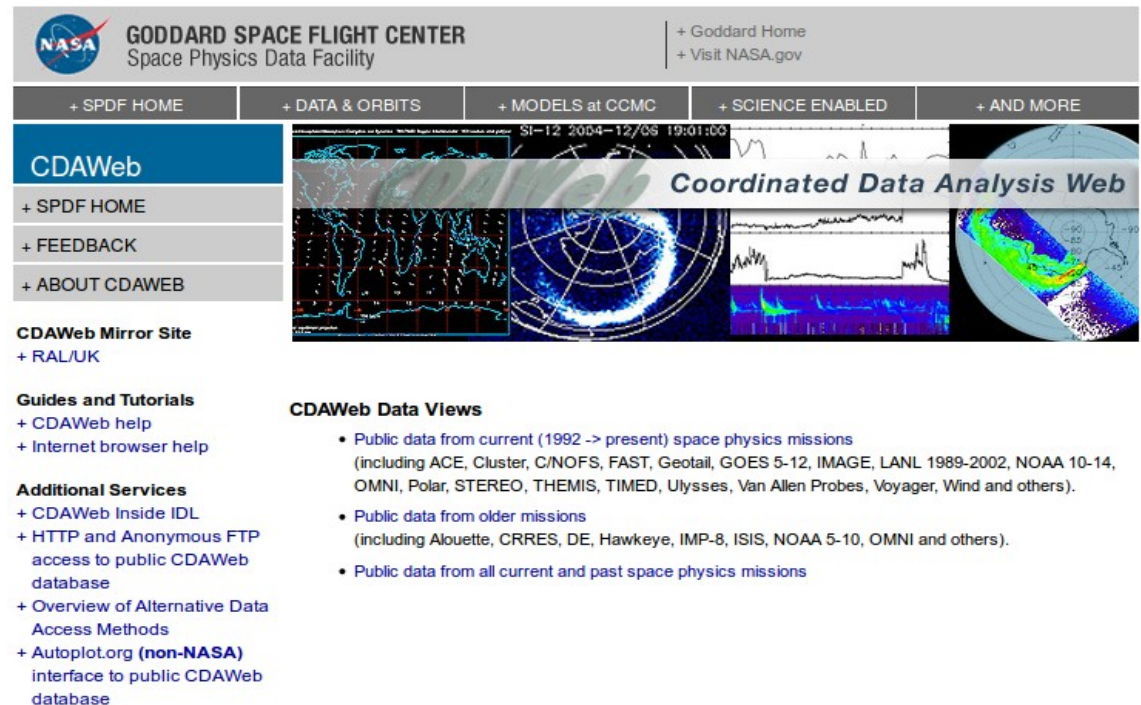
Energy coverage:

19–28 (~25) and 28–72 (~50) MeV

Identification:

visual scanning for enhancements: **1996–2015**

Data analysis: onset time, peak time, peak intensity

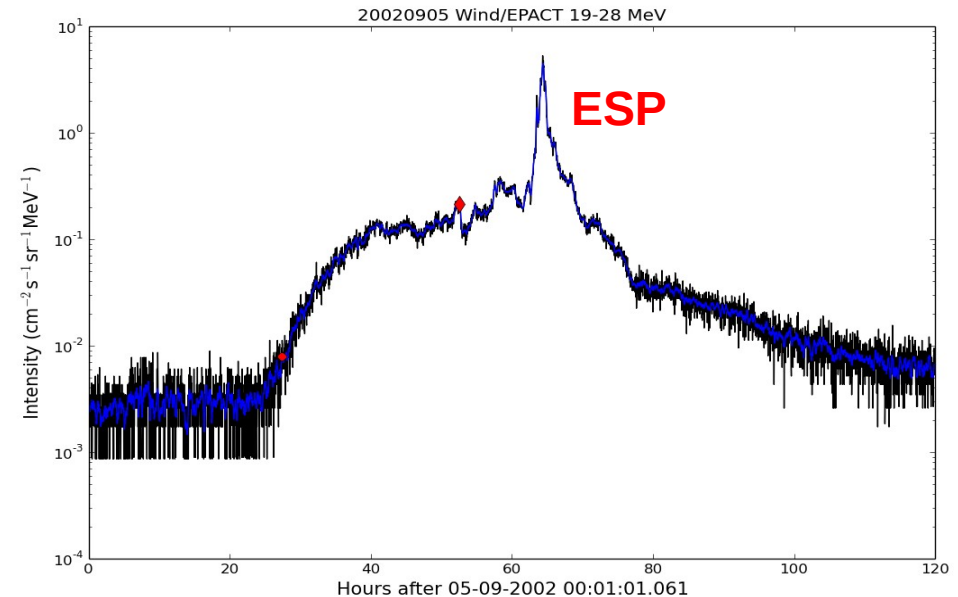


The screenshot displays the CDAWeb interface. At the top, it features the NASA logo and the text "GODDARD SPACE FLIGHT CENTER Space Physics Data Facility". Navigation links include "+ SPDF HOME", "+ DATA & ORBITS", "+ MODELS at CCMC", "+ SCIENCE ENABLED", and "+ AND MORE". A central banner reads "Coordinated Data Analysis Web" with a date and time stamp "SI-T2 2004-12/06 19:01:00". Below the banner are several data visualization panels, including a map of Earth's magnetic field and a plot of particle intensity. On the left side, there are links for "CDAWeb", "CDAWeb Mirror Site + RAL/UK", "Guides and Tutorials", and "Additional Services". On the right side, under "CDAWeb Data Views", there is a list of data sources:

- Public data from current (1992 -> present) space physics missions (including ACE, Cluster, C/NOFS, FAST, Geotail, GOES 5-12, IMAGE, LANL 1989-2002, NOAA 10-14, OMNI, Polar, STEREO, THEMIS, TIMED, Ulysses, Van Allen Probes, Voyager, Wind and others).
- Public data from older missions (including Alouette, CRRES, DE, Hawkeye, IMP-8, ISIS, NOAA 5-10, OMNI and others).
- Public data from all current and past space physics missions

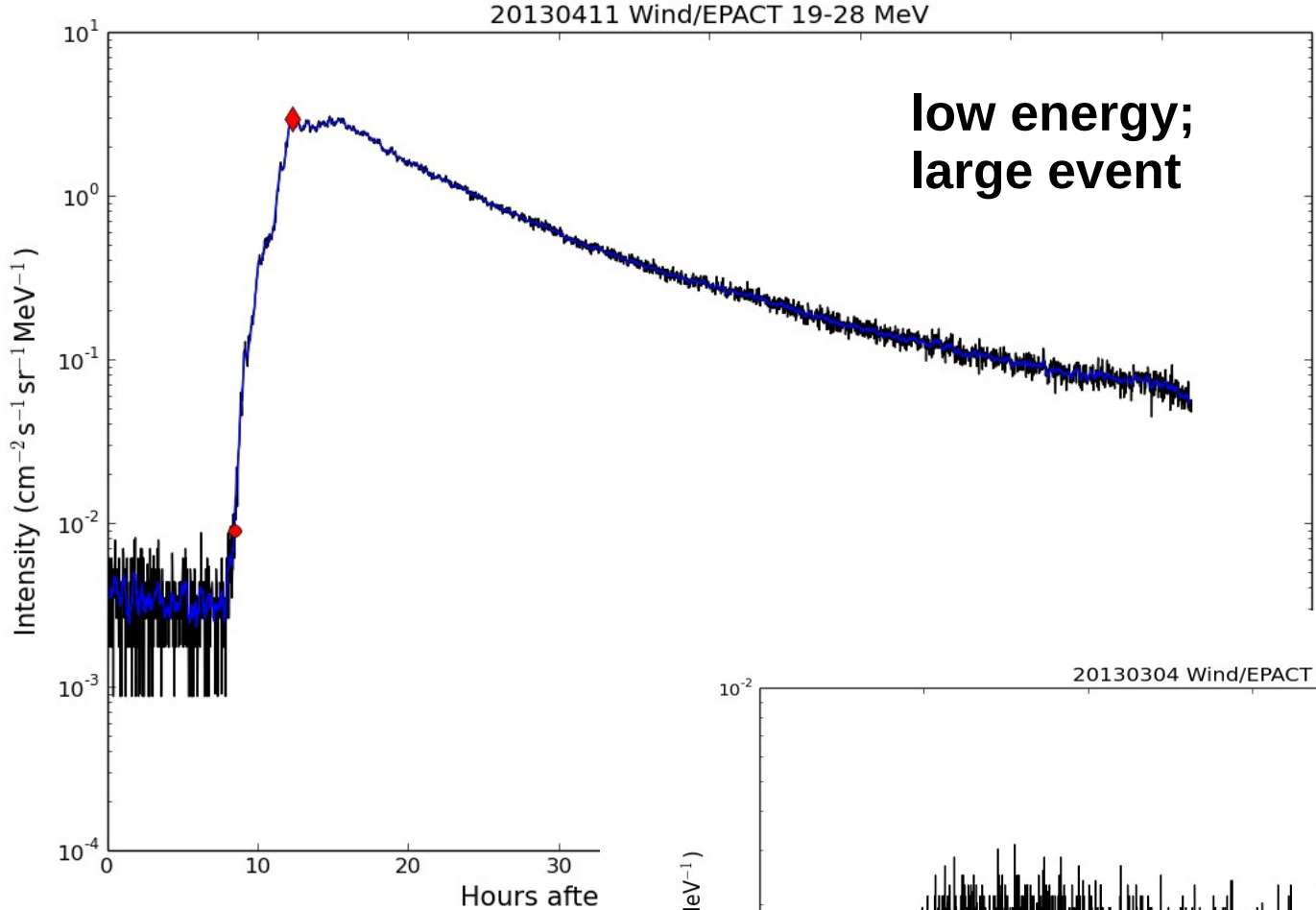
I. Wind/EPACT catalog: Aim

all events reported (no threshold);
2 energy channels;
correction for ESPs (example);
overview plots;
link to the data

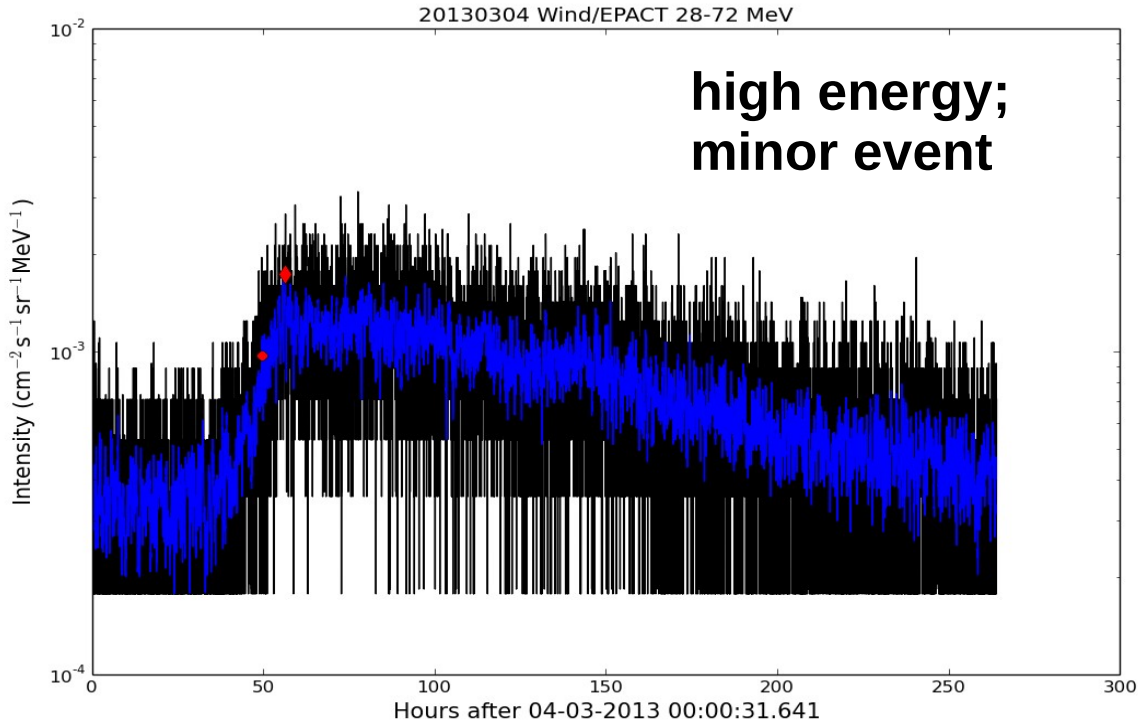


- 1) To compile comprehensive proton event list in solar cycles 23 & 24**
- 2) To provide proton event list suitable for scientific purposes**
- 3) To have regular updates**

Examples of proton profiles



- Onset
(3- σ above bg-level)
- ◆ Peak
- 5-point smoothing



Catalog of solar energetic particles from Wind/EPACT instrument

first version:
[newserver.stil.bas.bg/
SEPcatalog/index.html](http://newserver.stil.bas.bg/SEPcatalog/index.html)

[Solar cycle 23: 1996-2008](#)

Solar cycle 24: 2009-present

Event date	19-28 MeV			28-72 MeV	Flare	CME	Comment
yyyy-mm-dd	onset time (UT)	peak time (UT)	J_p ($\text{cm}^2 \text{ s sr MeV}^{-1}$)	J_p ($\text{cm}^2 \text{ s sr MeV}^{-1}$)	class/time /location	time/speed /width	
2009	-	-	-	-	-	-	no SEP events
2010-06-12	04:04	08:39	0.0123	plot			
2010-08-03	15:13	18:25	0.0478	plot			
2010-08-07	22:45	01:43 nd	0.0111	plot	TBA	TBA	
2010-08-07	u	11:22 nd	0.0074	plot			
2010-08-14	11:15	13:05	0.158	plot			
2010-08-18	08:01	12:18	0.0486	plot			
2010-09-09	03:02	04:25	0.0071	plot			
2011-01-28	02:32	05:13	plot	plot			
2011-01-28	11:31	13:37	plot	plot			
2011-02-15	05:04	10:24	plot	plot			
2011-03-07	22:33	10:03 nd	plot	plot			

Explanatory notes:

This catalog lists the proton enhancements in [Wind/EPACT](#) 19-28 and 28-72 MeV energy channels.

Proton data: from [CDAweb](#) database provided with 92-sec time resolution.

Onset time: identified as the time of 3-sigma intensity value above pre-event level.

Peak time: identified at the maximum of the particle profile (local enhancements are not considered).

J_p : maximum proton intensity after subtraction of the pre-event level.

The reported here onset/peak times and J_p are based on 5-point smoothed data.

N/A: onset not found and/or it was fully masked by previous ongoing event

nd: next day

pd: previous day

p: peak is poorly defined

u: uncertain

Acknowledgements:

If you use results from this catalog, we would appreciate the following acknowledgement:

'For catalog description and first results see Miteva et al. (Sun & Geosphere, *subm.*).'

Contact:

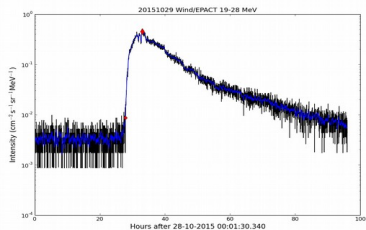
[R. Miteva](#)

Links:

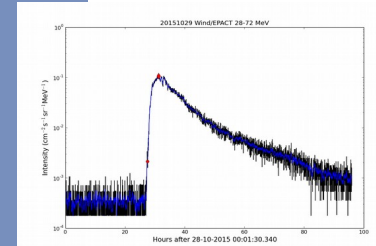
[Space Climate Group Homepage](#)

[Space Research and Technology Institute Homepage](#)

**19-28 MeV:
overview plot**



**28-72 MeV:
overview plot**



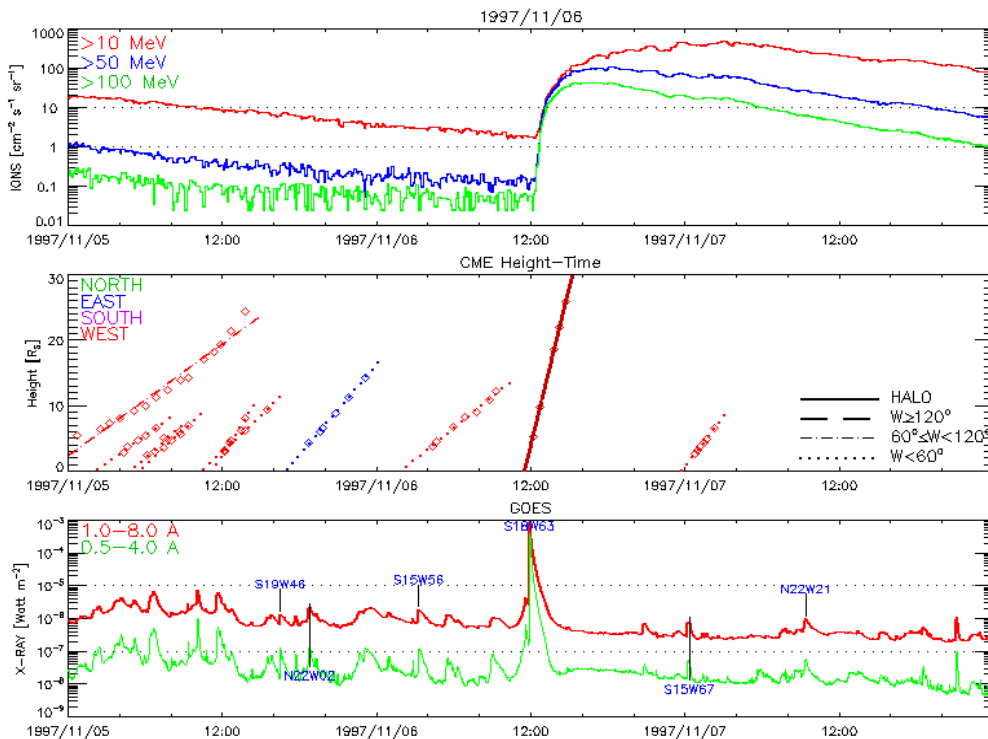
SEP origin: flares and CMEs

Criteria

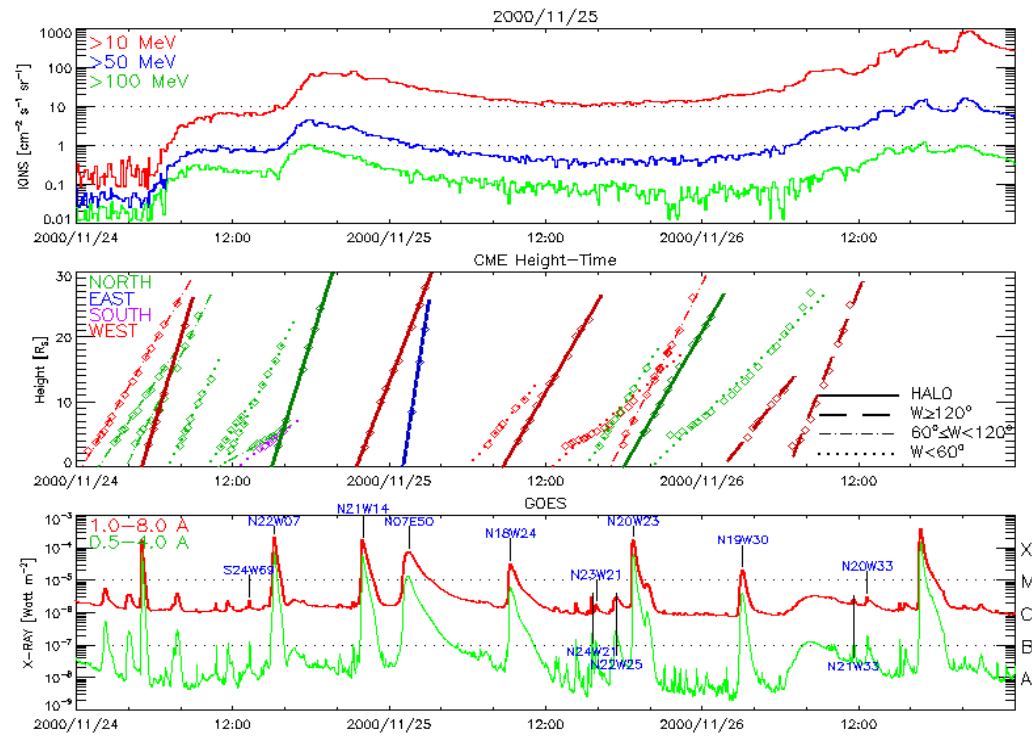
search for flare/CME in a time window before SEP onset;
 preference usually given to large flare/fast CME pair
 & to western origin candidates;
SEP-profile indicative of E/W origin;
electron timing aids to select the solar origin, etc.

Subjectivity issues

multiple flare/CMEs could contribute to the final SEP flux at 1 AU during times of high solar activity.

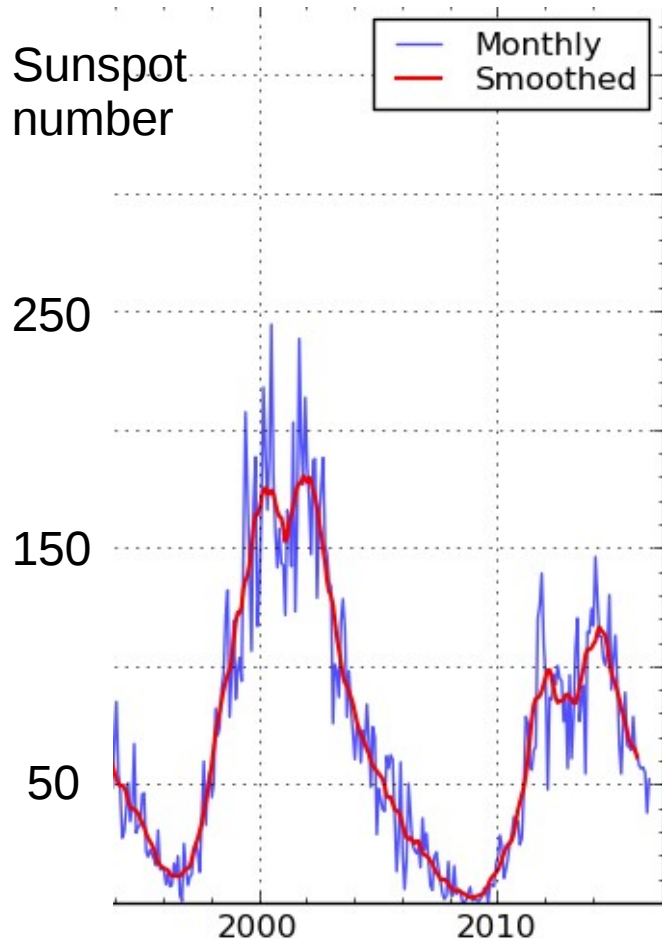


clear SEP-origin candidates



20–30% uncertain SEP-origin

Solar cycle comparison: first 7yr



Source: WDC-SILSO, Royal
Observatory of Belgium, Brussels

<http://www.sidc.be/silso/>

SC23

Minimum: August 1996 (Sn = 11.6)

SC23 onset: September 1996

7-yr end: August 2003

SC24

Minimum: December 2008 (Sn = 2.2)

SC24 onset: January 2009

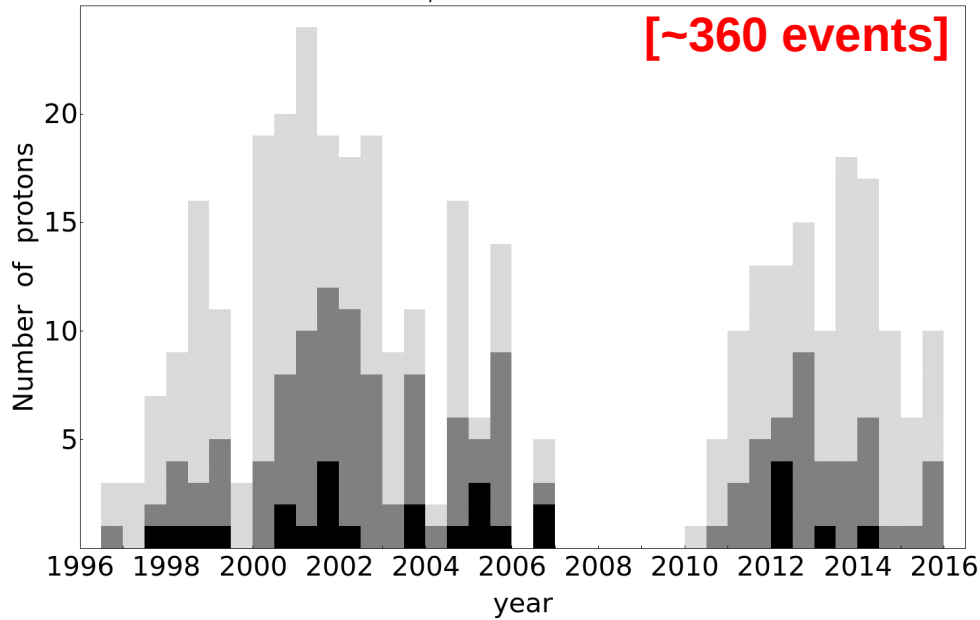
7-yr end: December 2015

(definitions: using 13-month smoothed
sunspot number)

$$\% \text{ change} = \left(\frac{\# \text{ in SC24}}{\# \text{ in SC23}} \right) - 1$$

Solar cycle dependence: Protons

Wind/EPACT ~25 MeV

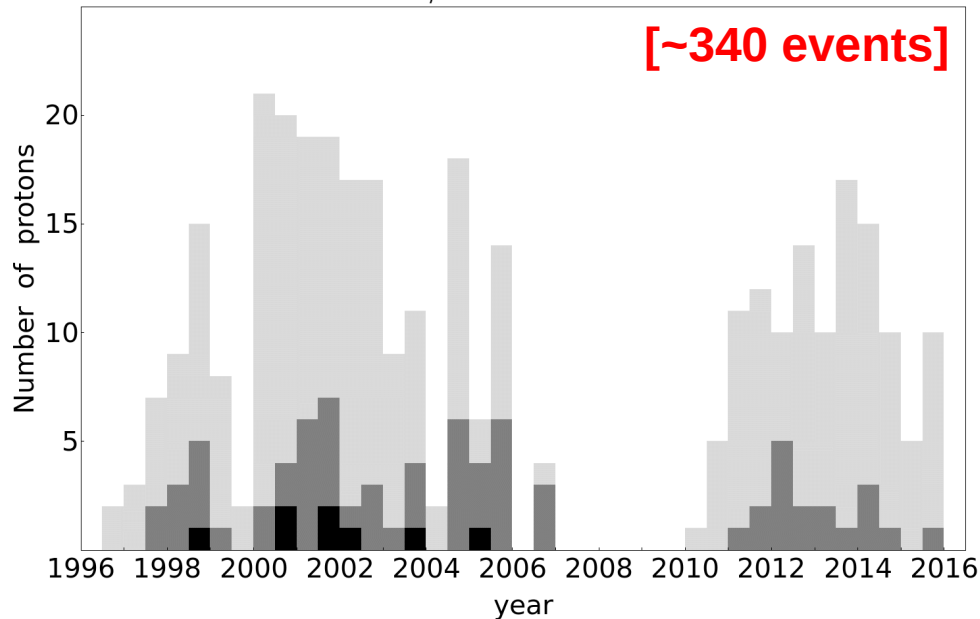


SC comparison: 7yr of data

% change in SC24 wrt SC23

All [~25 MeV]	$-30 \pm 8\%$
Major (≥ 1)	$-50 \pm 25\%$
Medium	$-36 \pm 13\%$
Minor (< 0.01)	$-24 \pm 11\%$

Wind/EPACT ~50 MeV



% change in SC24 wrt SC23

All [~50 MeV]	$-30 \pm 8\%$
Major (black)	-100%
Medium (gray)	$-40 \pm 18\%$
Minor (light)	$-23 \pm 10\%$

Overall decrease of solar proton events in SC24!

Solar cycle dependence: Flares

SEP-productive flares [~ 250]	
All (C-to-X)	$-38 \pm 9\%$
X-class	$-50 \pm 15\%$
M-class	$-39 \pm 12\%$
C-class	$-24 \pm 21\%$

vs.

All flares [>35000]	
All (C-to-X)	$-34 \pm 1\%$
X-class	$-44 \pm 10\%$
M-class	$-38 \pm 3\%$
C-class	$-33 \pm 1\%$

Overall decrease in SC24!



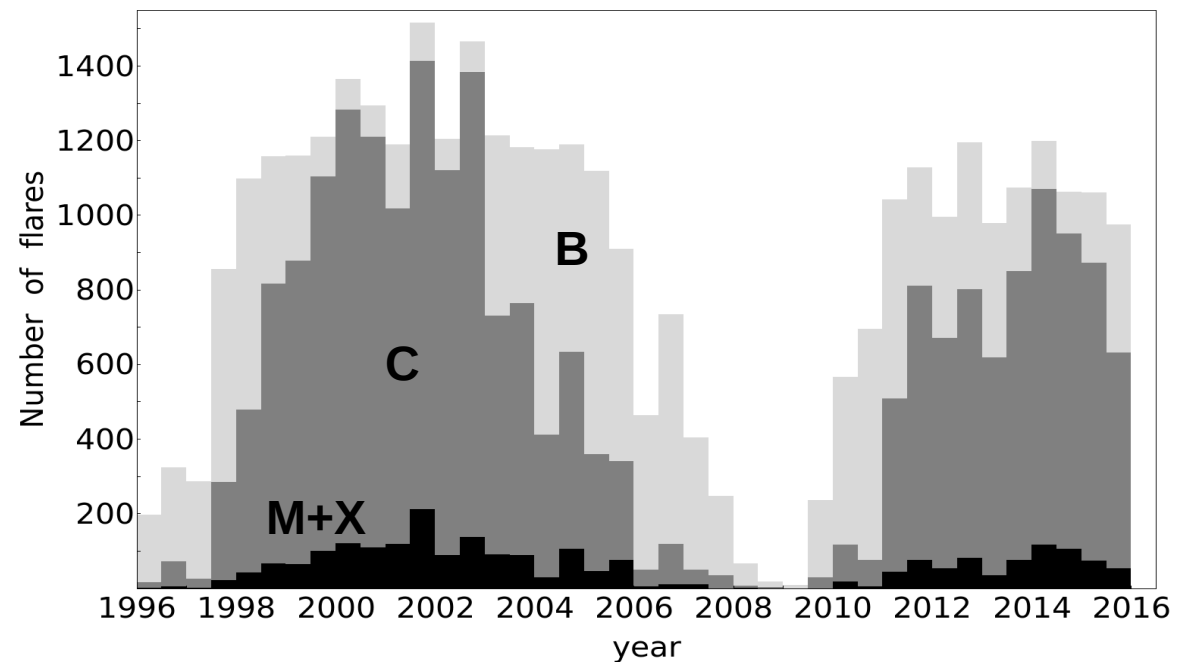
**Pearson log-log
correlation coefficient:**

J_p -ISXR

0.43 ± 0.05 (all)

0.34 ± 0.08 (SC23)

0.39 ± 0.09 (SC24)



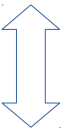
Solar cycle dependence: CMEs

SEP-productive CMEs [~ 280]	
All	$-22 \pm 10\%$
≥ 1000 km/s	$-26 \pm 13\%$
< 1000 km/s	$-16 \pm 16\%$
halo*	$+18 \pm 20\%$
non-halo* ($< 360^\circ$)	$-59 \pm 9\%$
narrow* ($< 100^\circ$)	$-90 \pm 7\%$

All CMEs [> 26000]	
All	$+61 \pm 2\%$
≥ 1000 km/s	$-46 \pm 5\%$
< 1000 km/s	$+66 \pm 2\%$

vs.

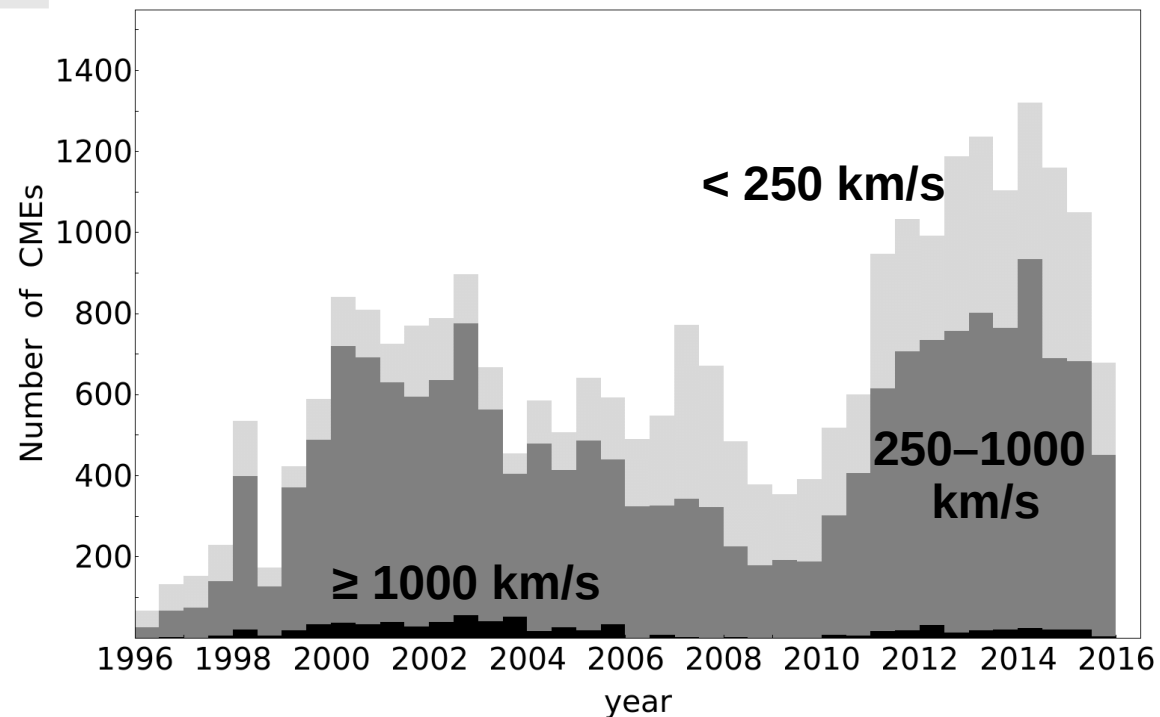
Decrease/increase in SC24!



* no restriction on CME speed

**Pearson log-log
correlation coefficient:
 $J_p - V_{CME}$**

**0.50 ± 0.05 (all)
 0.45 ± 0.08 (SC23)
 0.51 ± 0.07 (SC24)**



Future plans

Release: end **2016**

Planned updates: yearly

Additions: information of related flares/CMEs;
search/sort options for on-line catalog

Support: Space Climate Group
@Space Research and Technology Institute
Bulgarian Academy of Sciences

Link: <http://newserver.stil.bas.bg/SEPcatalog/index.html>