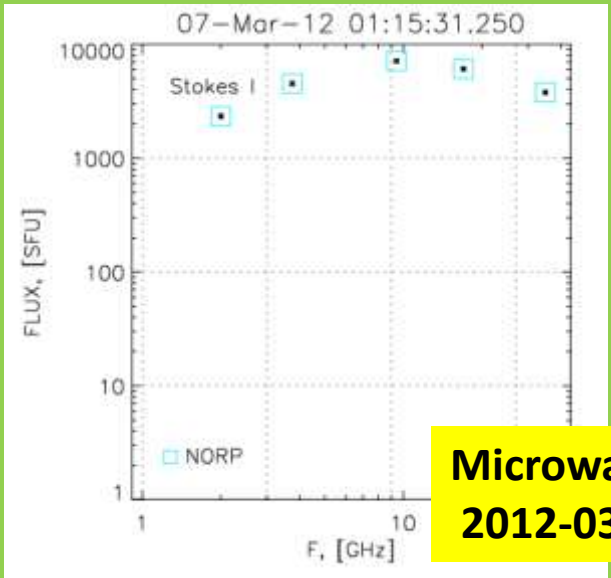
About productivity of the solar energetic particle events

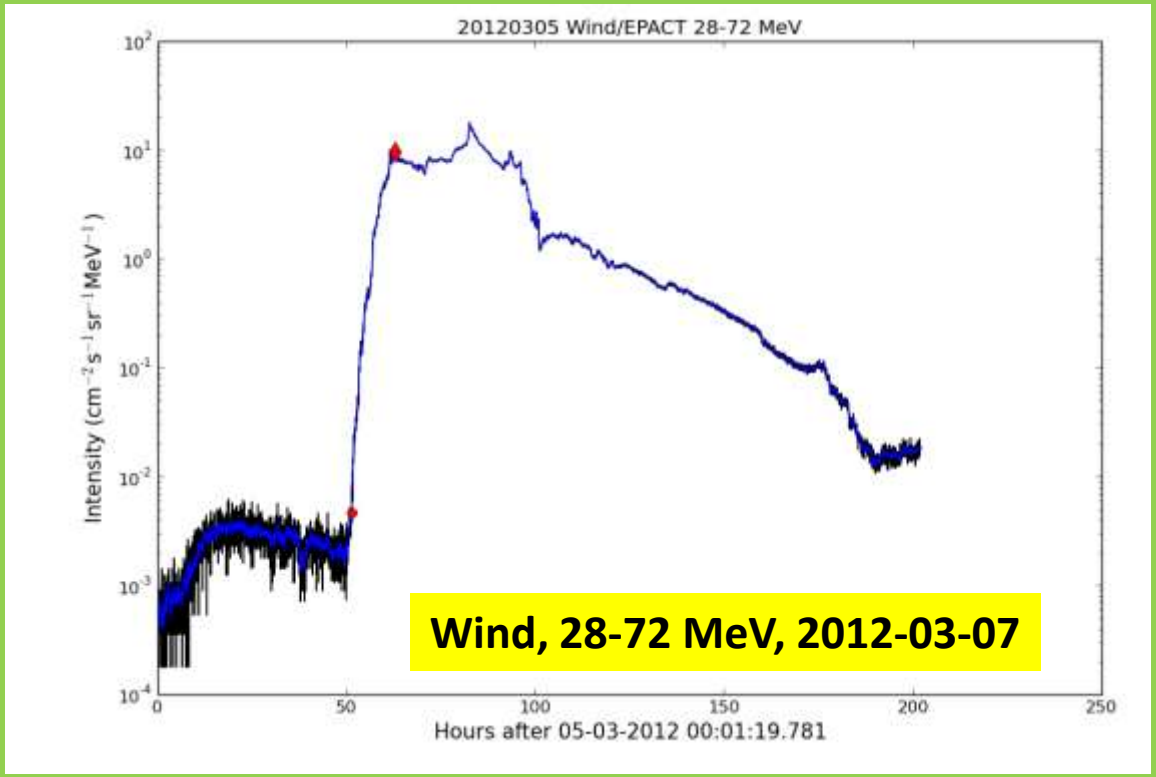
Dmitrii Zhdanov, L. Kashapova, I. Myshyakov, R. Miteva

The Badary Radio Astrophysical Observatory of ISTP SB RAS Irkutsk, Russia
The Space Research and Technology Institute of the Bulgarian Academy of Sciences, Sofia, Bulgaria

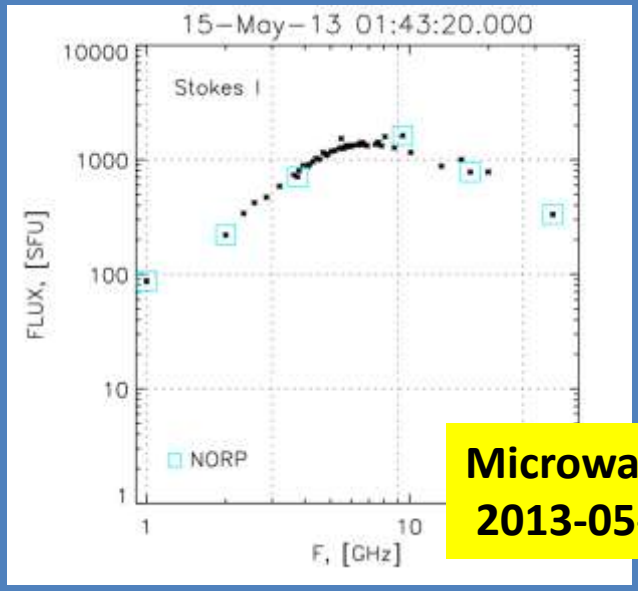
Primorsko 2019



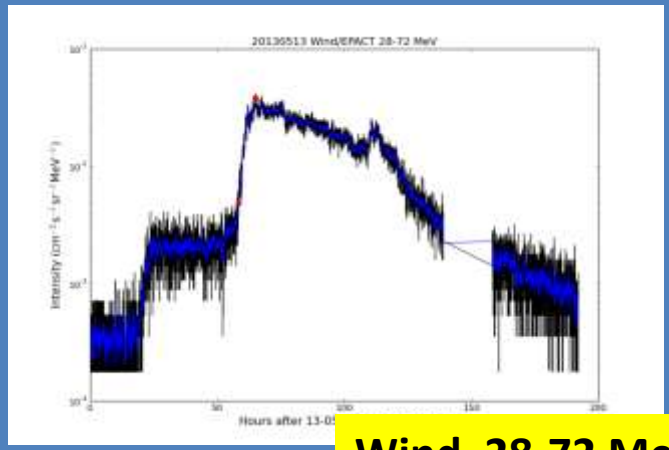
Microwaves 2012-03-07



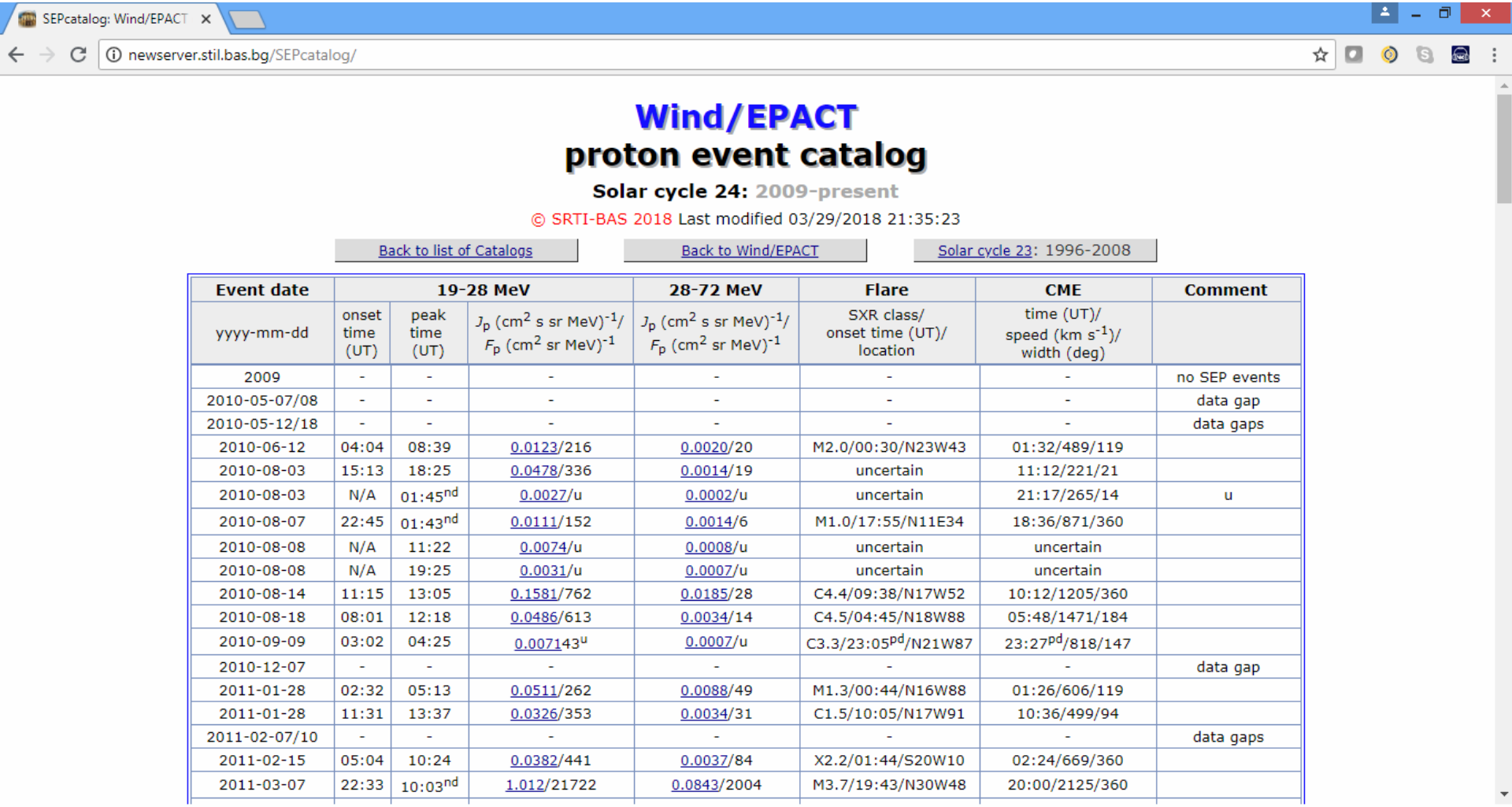
Wind, 28-72 MeV, 2012-03-07



Microwaves 2013-05-13



Wind, 28-72 MeV, 2013-05-13



Wind/EPACT
proton event catalog

Solar cycle 24: 2009-present

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Back to list of Catalogs | Back to Wind/EPACT | Solar cycle 23: 1996-2008

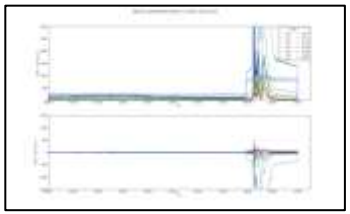
Event date	19-28 MeV			28-72 MeV	Flare	CME	Comment
yyyy-mm-dd	onset time (UT)	peak time (UT)	J_p (cm^2 s sr MeV)$^{-1}$/ F_p (cm^2 sr MeV)$^{-1}$	J_p (cm^2 s sr MeV)$^{-1}$/ F_p (cm^2 sr MeV)$^{-1}$	SXR class/ onset time (UT)/ location	time (UT)/ speed (km s^{-1})/ width (deg)	
2009	-	-	-	-	-	-	no SEP events
2010-05-07/08	-	-	-	-	-	-	data gap
2010-05-12/18	-	-	-	-	-	-	data gaps
2010-06-12	04:04	08:39	0.0123/216	0.0020/20	M2.0/00:30/N23W43	01:32/489/119	
2010-08-03	15:13	18:25	0.0478/336	0.0014/19	uncertain	11:12/221/21	
2010-08-03	N/A	01:45nd	0.0027/u	0.0002/u	uncertain	21:17/265/14	u
2010-08-07	22:45	01:43nd	0.0111/152	0.0014/6	M1.0/17:55/N11E34	18:36/871/360	
2010-08-08	N/A	11:22	0.0074/u	0.0008/u	uncertain	uncertain	
2010-08-08	N/A	19:25	0.0031/u	0.0007/u	uncertain	uncertain	
2010-08-14	11:15	13:05	0.1581/762	0.0185/28	C4.4/09:38/N17W52	10:12/1205/360	
2010-08-18	08:01	12:18	0.0486/613	0.0034/14	C4.5/04:45/N18W88	05:48/1471/184	
2010-09-09	03:02	04:25	0.007143^{u}	0.0007/u	C3.3/23:05^{pd}/N21W87	23:27^{pd}/818/147	
2010-12-07	-	-	-	-	-	-	data gap
2011-01-28	02:32	05:13	0.0511/262	0.0088/49	M1.3/00:44/N16W88	01:26/606/119	
2011-01-28	11:31	13:37	0.0326/353	0.0034/31	C1.5/10:05/N17W91	10:36/499/94	
2011-02-07/10	-	-	-	-	-	-	data gaps
2011-02-15	05:04	10:24	0.0382/441	0.0037/84	X2.2/01:44/S20W10	02:24/669/360	
2011-03-07	22:33	10:03nd	1.012/21722	0.0843/2004	M3.7/19:43/N30W48	20:00/2125/360	

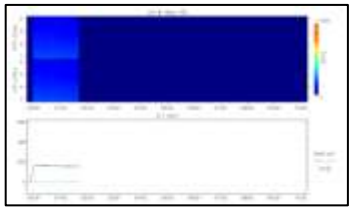
http://newserver.stil.bas.bg/SEPcatalog/

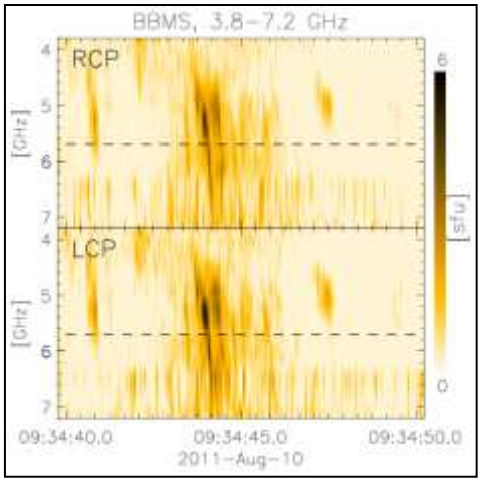
total **172** events (2010-2017)

Miteva et al. (2016) and Miteva et al. (2017)

SOLAR MICROWAVE OBSERVATIONS







single dish
RCP & LCP,
band: **3.8-8.2 GHz** (26 ch.)
cadence: **10 ms, 0.7s**

4-8 GHz spectropolarimeter (BBMS)

single dish
RCP & LCP,
band: **2-24 GHz** (16 ch.)
cadence: **1.6 s**

2-24 GHz spectropolarimeter (SRS)

Cross-check of databases

- SEP database
- MW database (from 2 to 24 GHz)

Limit by time (00 UT – 10 UT) from 2010-2017

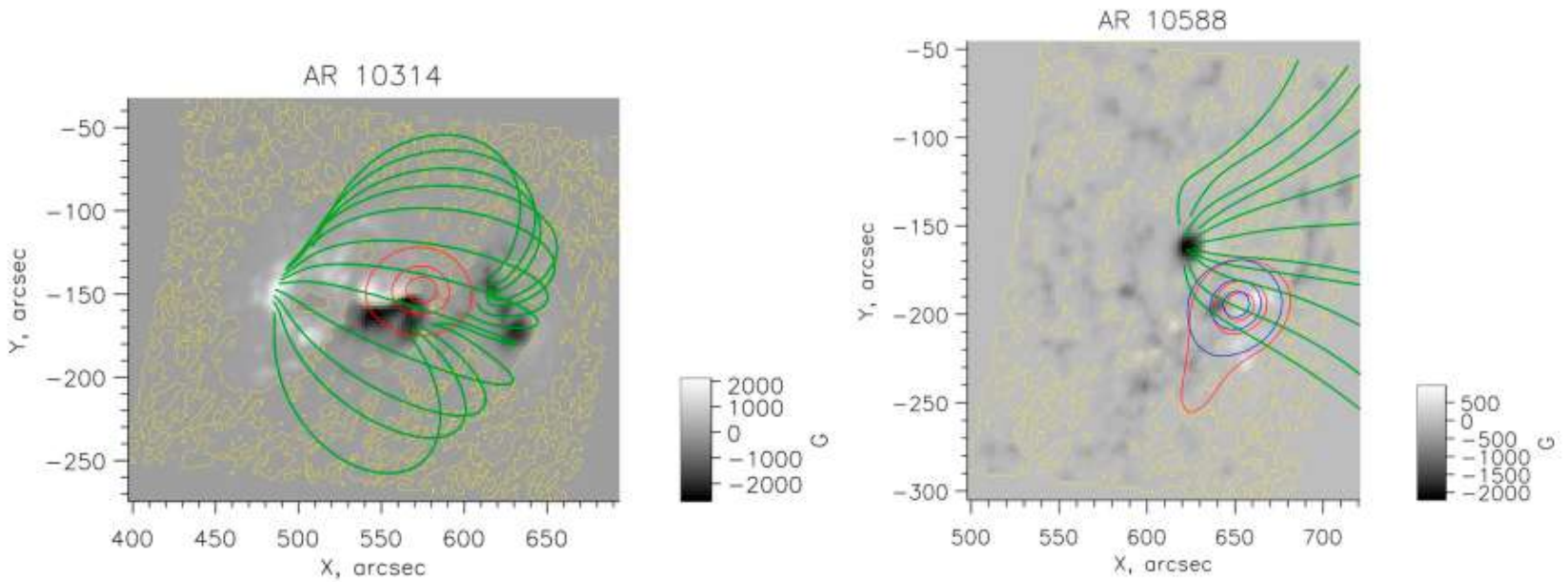
18 events (from 40) – typical microwave bursts.

1) Plot MW spectrum
2) Find flux maximum
3) Find spectral maximum
4) Check existing polarization of radiation

Zhdanov et al. 2019

Bogomolov et al. 2019

«One of the indicators of the existence of advanced possibilities for proton escaping could be the domination of **open magnetic field lines** in the AR producing the event.»



Bogomolov et al. 2019

Aim of work

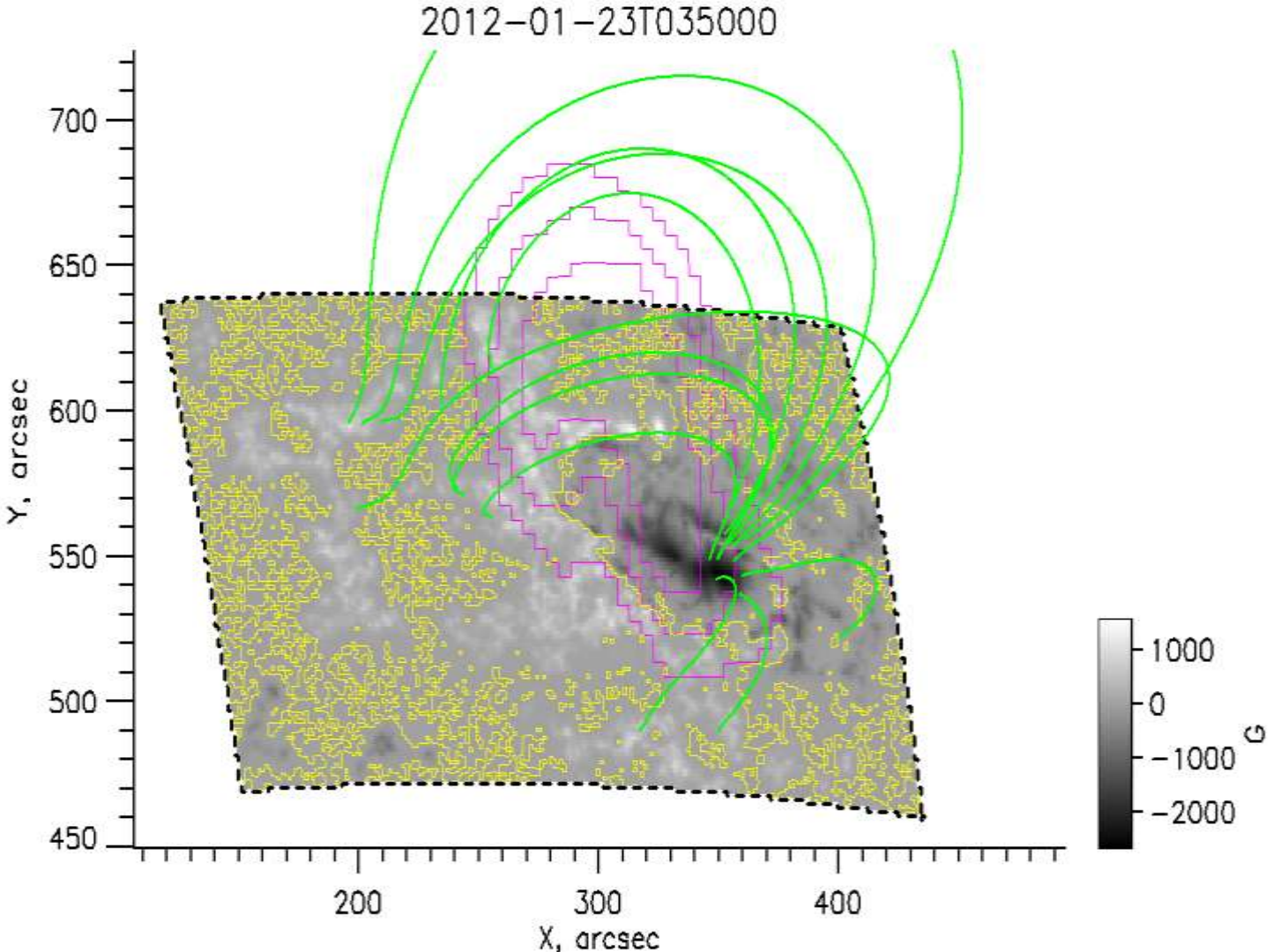
How the magnetic field topology of active regions influence on the productivity of Solar Energetic Particle events (SEPs)?

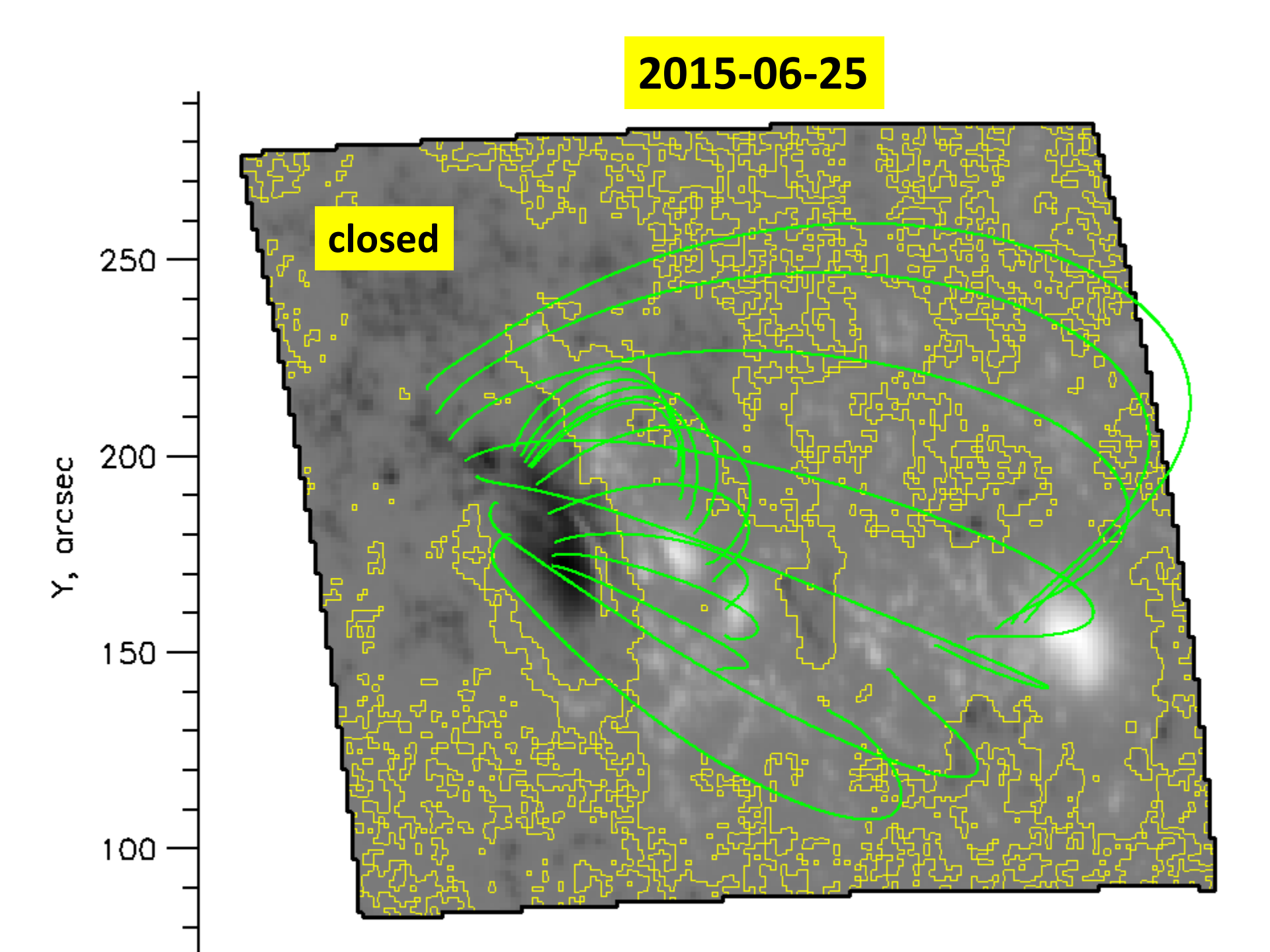
Data analysis

N°	Date (yyyy mm d d)	Time (UT)	GOES class	$Flux_{max}$ (sfu)	J flux 28-72 MeV	Position E-W	speed CME km/s
2	2011-08-09	07:48	X6.9	2000	0.1270/284	W69	1610
0	2011-02-15	01:44	X2.2	1000	0.0037/84	W10	669
4	2012-03-07	01:05	X1.3	7000	9.591/106851	E12	1825
7	2013-05-15	01:25	X1.2	1600	0.0352/484	E64	1366
3	2012-01-23	03:38	M8.7	8000	9.455/196610	W21	2175
11	2014-12-17	04:25	M8.7	800	0.0016/107	E09	587
14	2015-06-25	08:02	M7.9	4500	0.0142/1093	W42	1627
17	2016-07-23	05:00	M7.6	700	0.0004/u	W73	835
16	2016-04-18	00:14	M6.7	350	0.0007/u	W62	1084
5	2012-05-17	01:25	M5.1	600	1.357/1296	W76	1582
10	2014-02-20	07:26	M3.0	500	0.0309/272	W73	948
8	2013-06-21	02:30	M2.9	110	0.0073/153	E73	1900
13	2015-06-21	02:06	M2.6	1100	0.0203/266	E10	1366
1	2011-06-07	06:16	M2.5	800	0.3390/7315	W54	1255
12	2015-06-18	00:33	M1.2	60	0.0252/296	W81	1714
6	2013-03-15	05:46	M1.1	120	0.0004/u	E12	1063
9	2013-11-02	04:40	C8.2	80	0.0142/326	W04	828
15	2016-03-16	06:34	C2.2	12	0.0024/14	W88	592

Closed magnetic field configuration

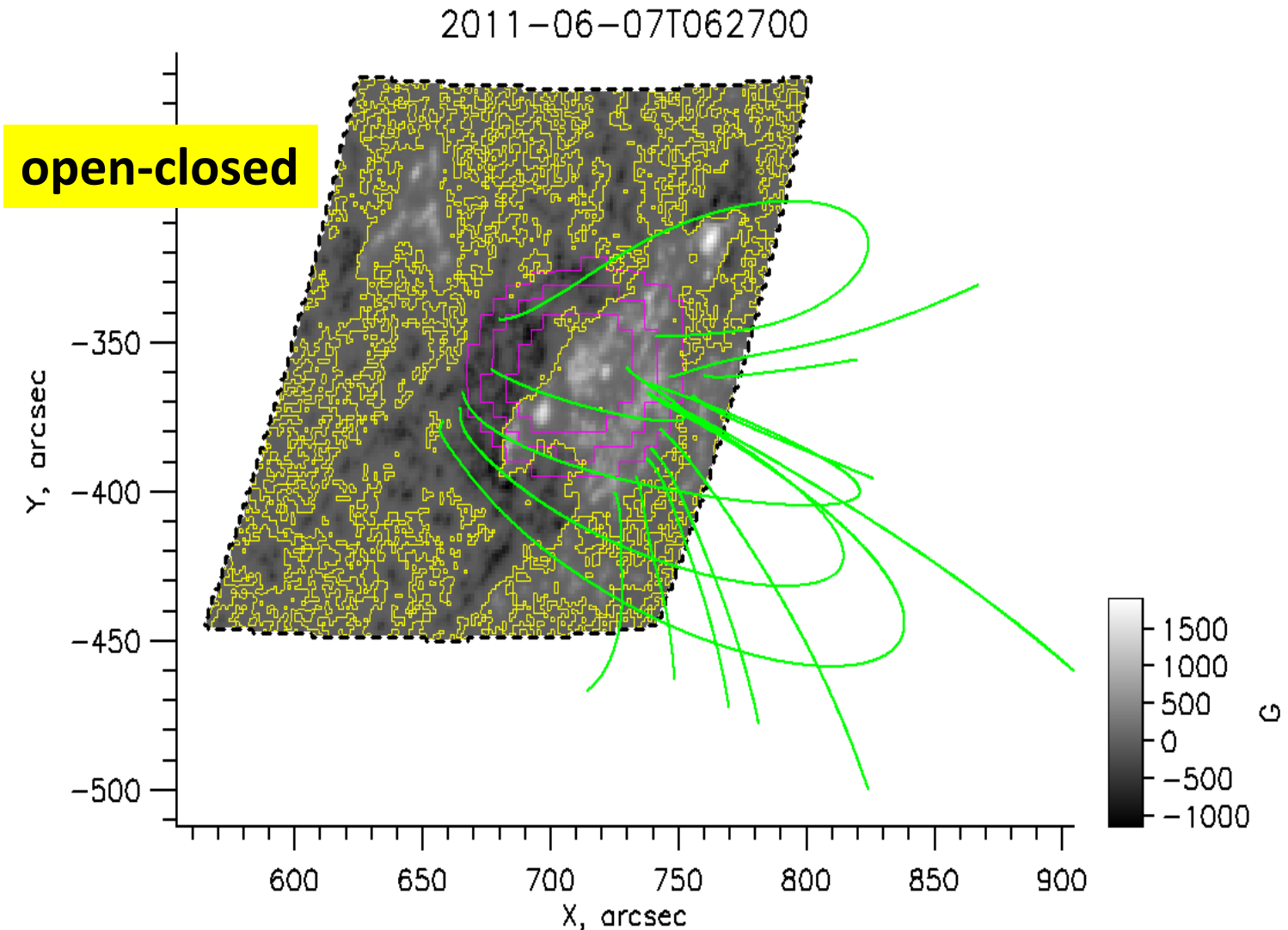
in event 2012-01-23



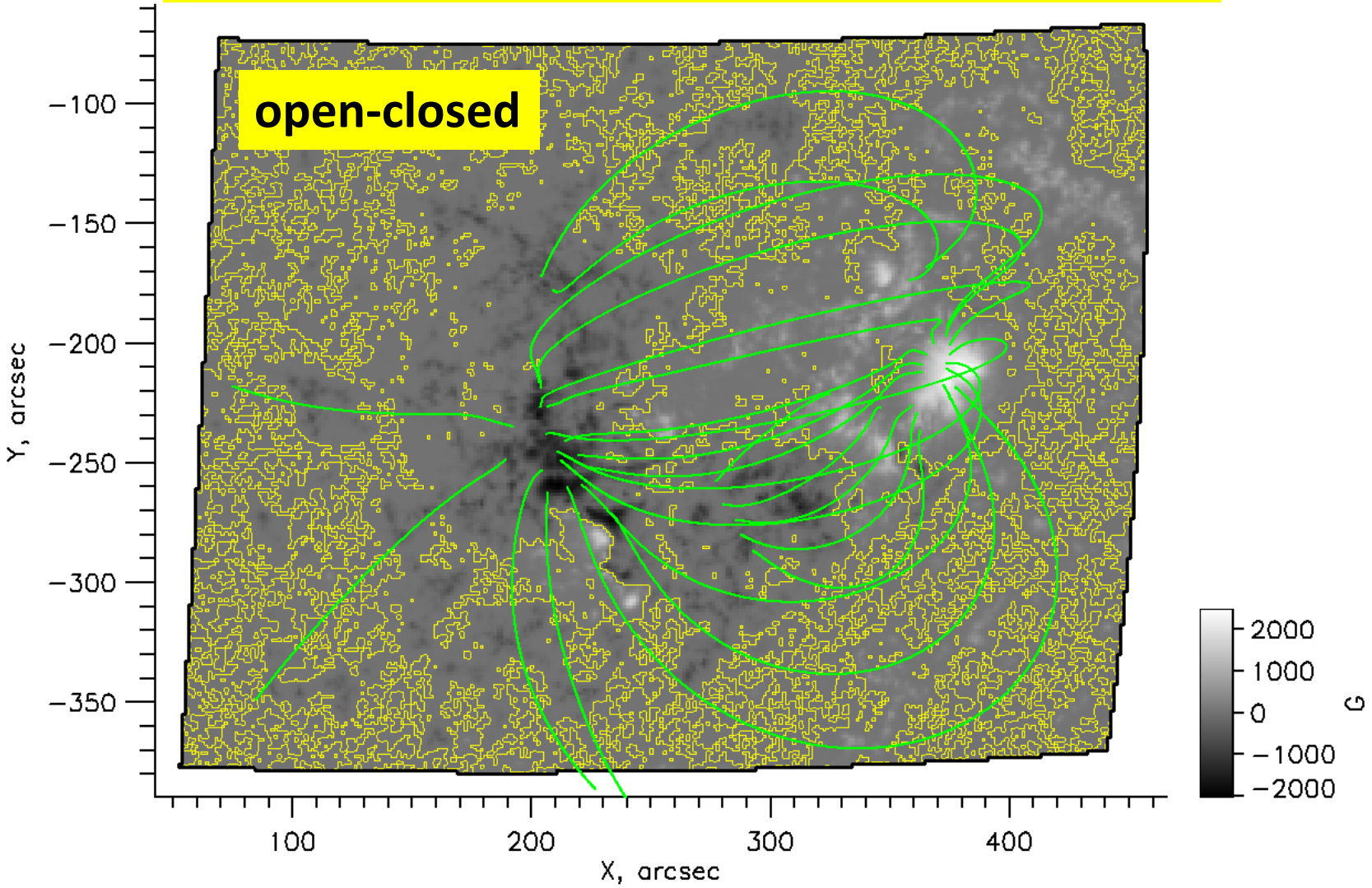

2015-06-25
closed
250
200
150
100
Y, arcsec

Open-closed magnetic field configuration

in event 2011-06-07

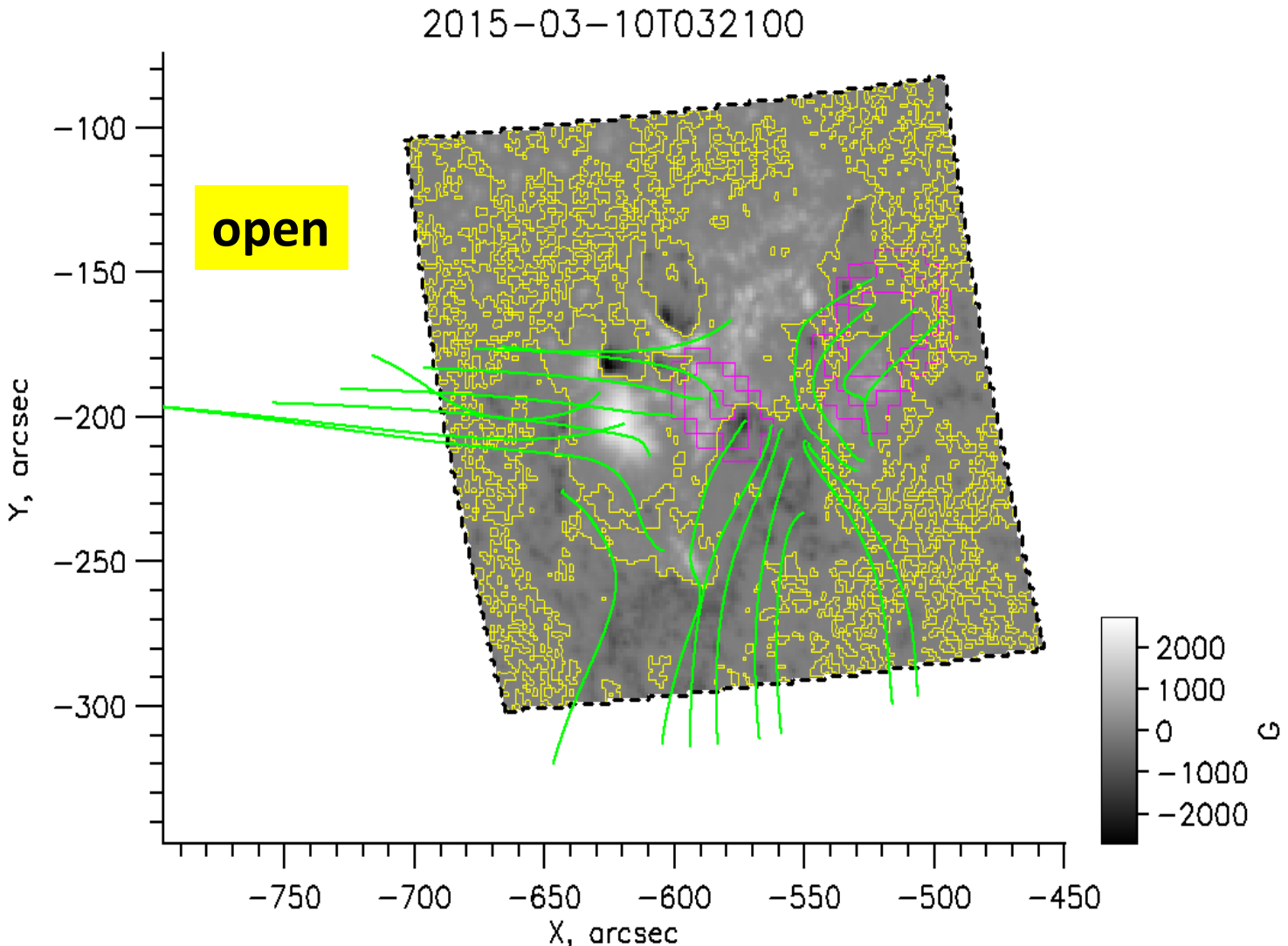


2013-11-10 set data №2 (18), no SEPs



Open magnetic field configuration

in event 2015-03-10



Summary of results magnetic configuration

- Total SEP events – 18:
  - **9** closed
  - **4** open-closed
  - **NO** open
  - 5 events near solar limb

- Additional data set without SEP - 3
  - **2** closed
  - **1** open (M5.1, $Flux_M$ – 1100sfu)

Conclusion

Initially, we assumed that the open configuration of the magnetic field could lead to more productive proton events than the closed configuration:

- However, we found the **closed configuration** of the magnetic field in most proton events (9 out of 17).

- We did not find clear open magnetic configurations in the studied proton events, however some configurations look like the open-closed configurations. We found **open-closed configuration** of the magnetic field in only 4 proton events out of 17.

- We found only one event where the magnetic field configuration was clearly **open**. Unfortunately, this event is from the set of unproductive events.

Thank you for your attention

The Siberian Solar Radio Telescope