Shock ahead ICMEs analyzed from *in situ* data

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Summary

- analyzed solar wind disturbances recorded by WIND satellite in the period from 2008 to 2013.
- associated with corresponding ICMEs recorded in Solar Terrestrial Relations Observatory (STEREO) data, for same period.
- ICMEs kinematic and arrival time calculation
- solar wind disturbances with recognized turbulent sheath and ICME body.
- relationships between parameters of the solar wind disturbances, compare with decrease in cosmic ray intensity and Dst index

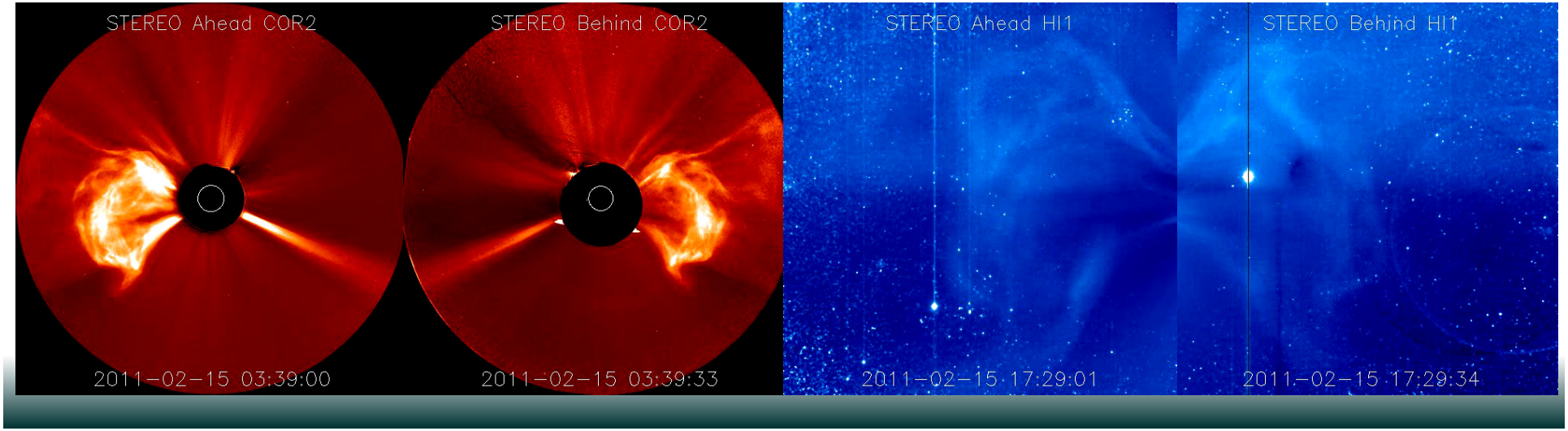
The data set

For solar wind disturbances at L1 point we used the Wind MFI and SWE Data, 1 minute resolution, GSE coordinates
http://wind.nasa.gov/mfi_swe_plot.php

For recognizing of the accompained ICME we used instruments from STEREO satellites

- SECCHI-COR2 Outer Coronagraph (NRL)
- SECCHI-HI Heliospheric Imager

http://stereo-ssc.nascom.nasa.gov/browse/



The data set

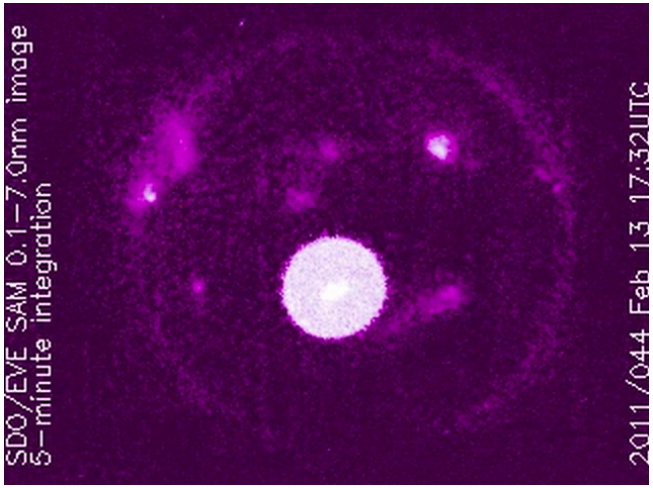
For additional information we used the

- SDO Extreme ultraviolet Variability Experiment (EVE) - SXR irradiance flux channel 0.1 – 7 nm

http://lasp.colorado.edu/eve/data_access/service/file_download/index.html

- SDO/EVE SAM pinchole camera

http://lasp.colorado.edu/eve/data_access/



Accompained by

- Cosmic ray intensity -

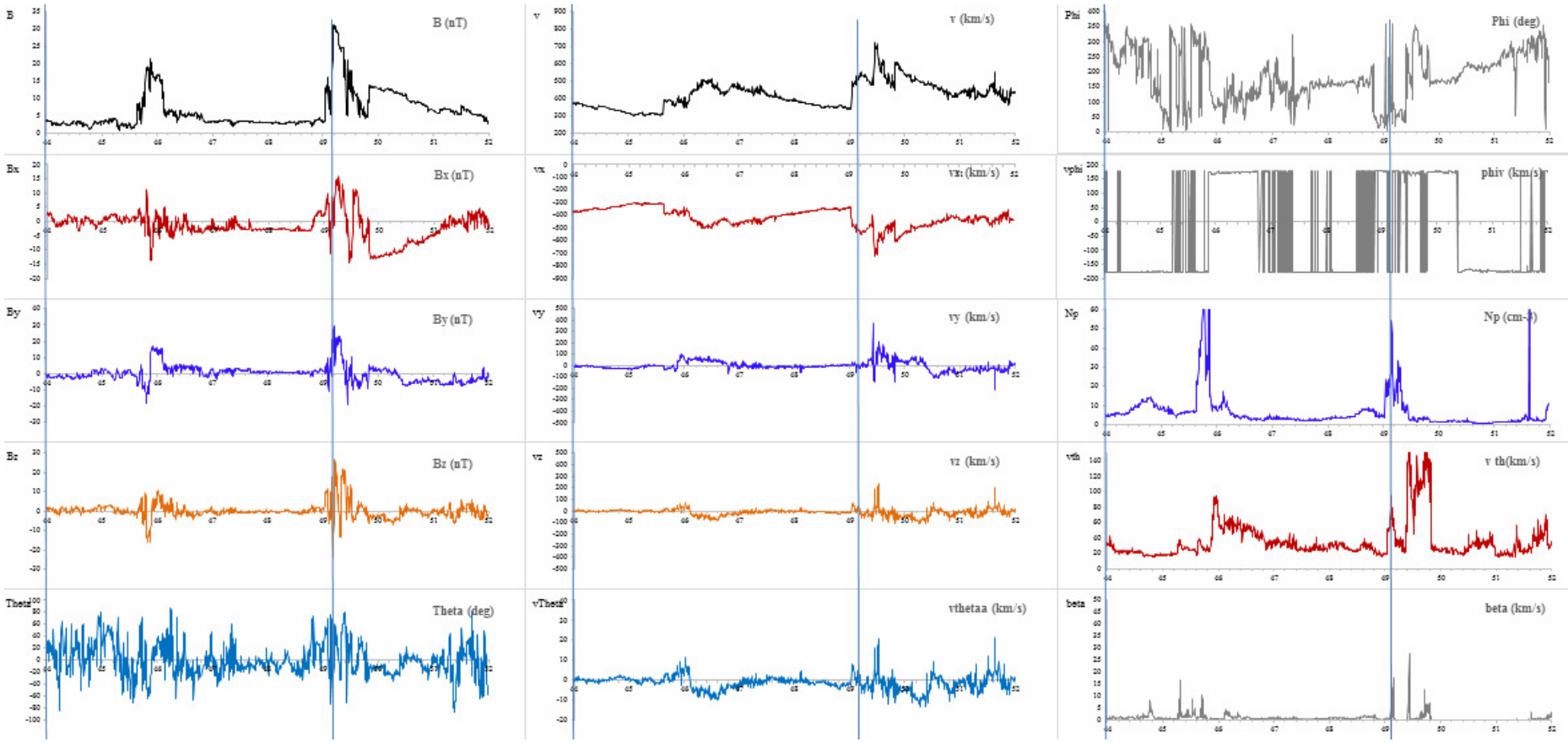
Moscow neutron monitor

http://cr0.izmiran.rssi.ru/mosc/main.htm

- WDC for Geomagnetism, Kyoto, Hourly Equatorial Dst Values

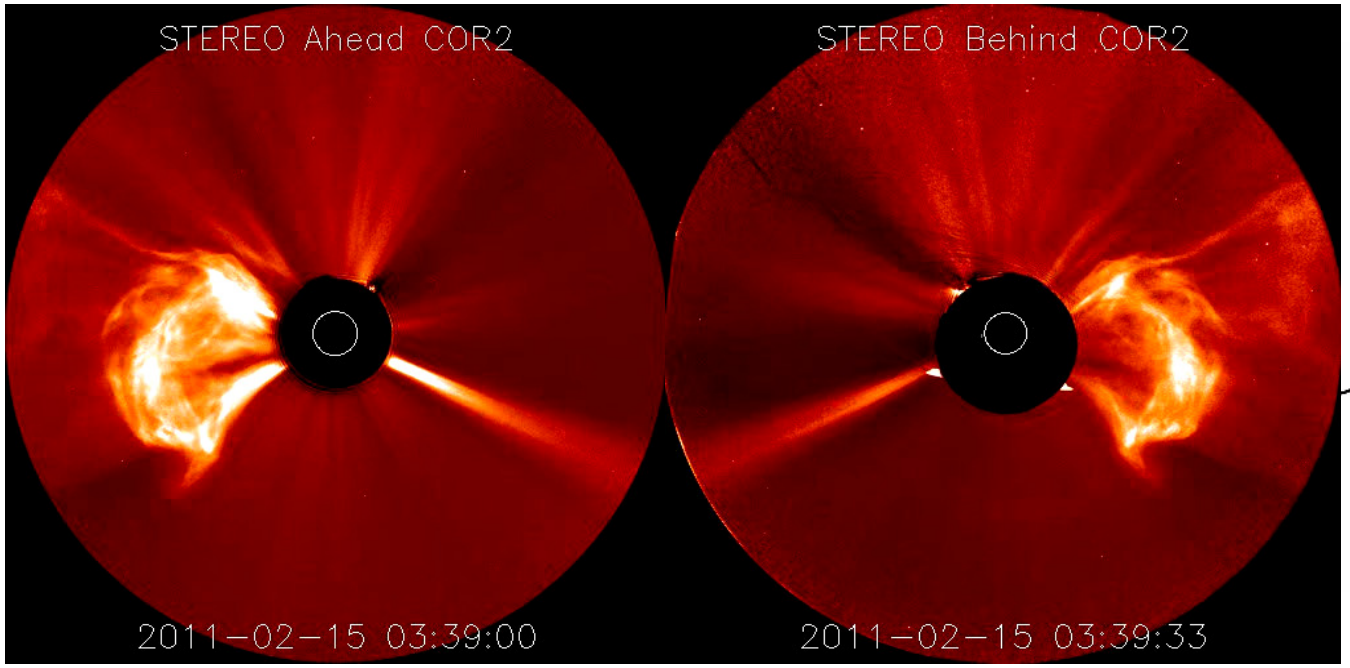
http://wdc.kugi.kyoto-u.ac.jp/dstdir/index.html

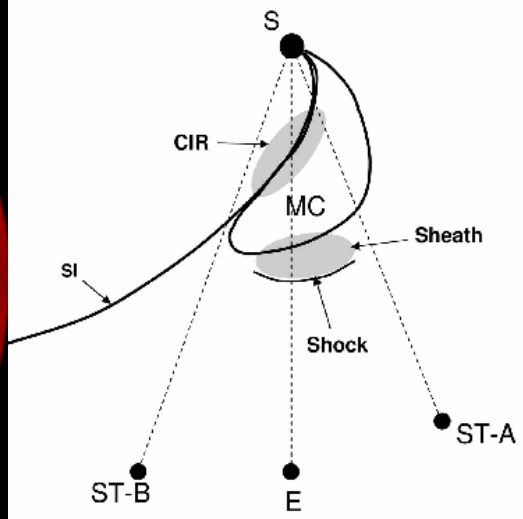
Solar wind disturbances



- For period from 2008 to 2013 - recognized 216 solar wind disturbances

ICME counting





- for the analyzed period recognized 1536 CME-s
- compare data with SOHO and STEREO catalog

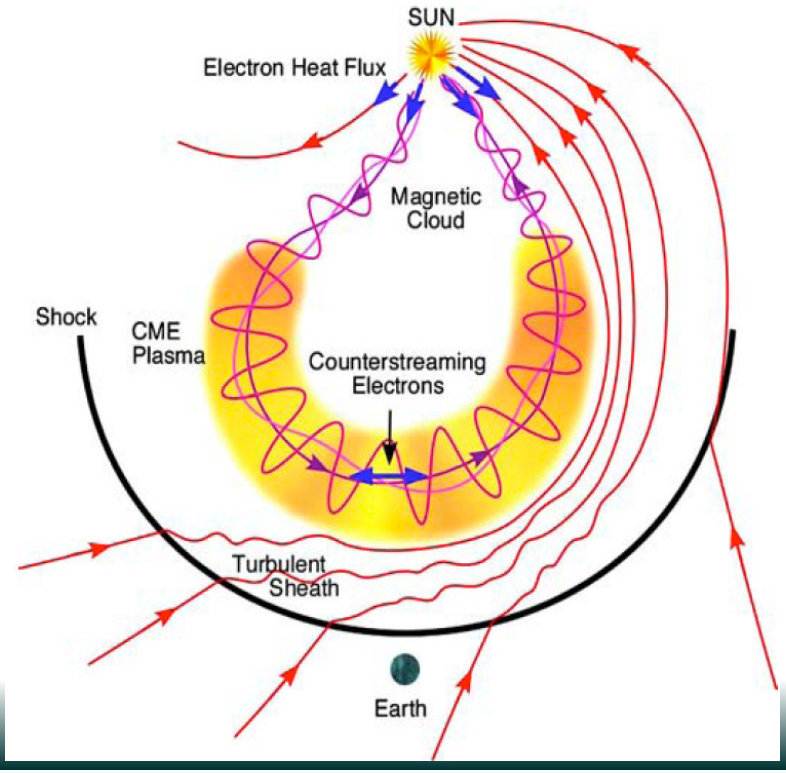
http://spaceweather.gmu.edu/seeds/monthly.php?a=2013&b=08&cor2

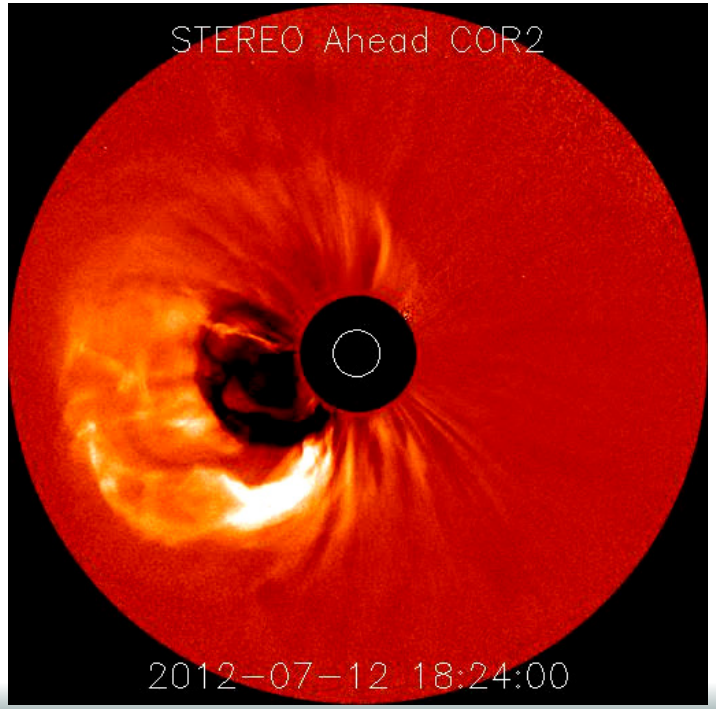
http://spaceweather.gmu.edu/seeds/lasco.php

- 301 of them have East STEREO A and West STEREO B direction

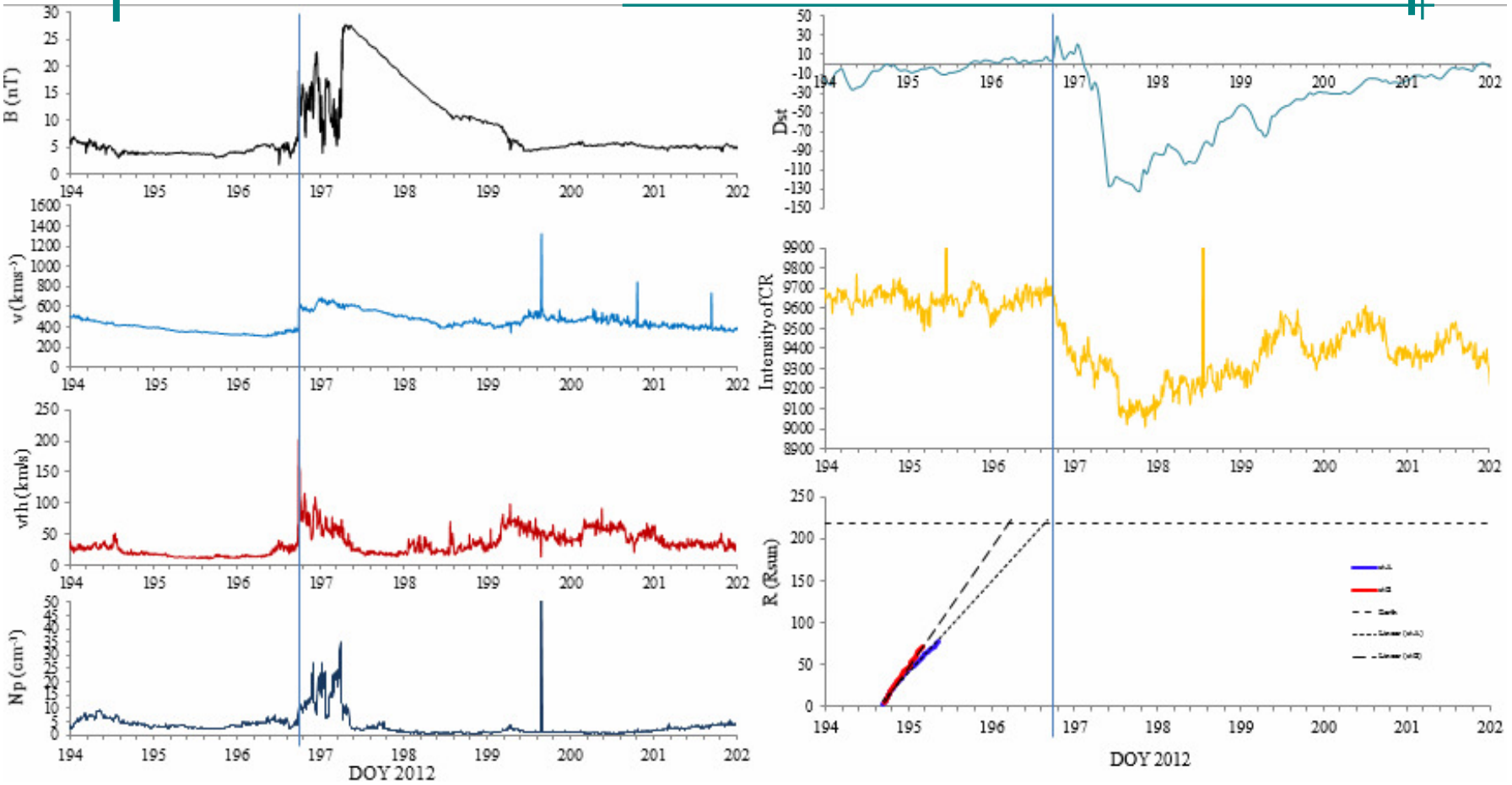
kinematics of the ICMEs

- from 186 of 301 CME-s it was possible connected with 136 corresponding solar wind disturbances
- Separation of the disturbance in different types
- from 56 of 186 CME-s have solar wind disturbances with recognized turbulent sheath



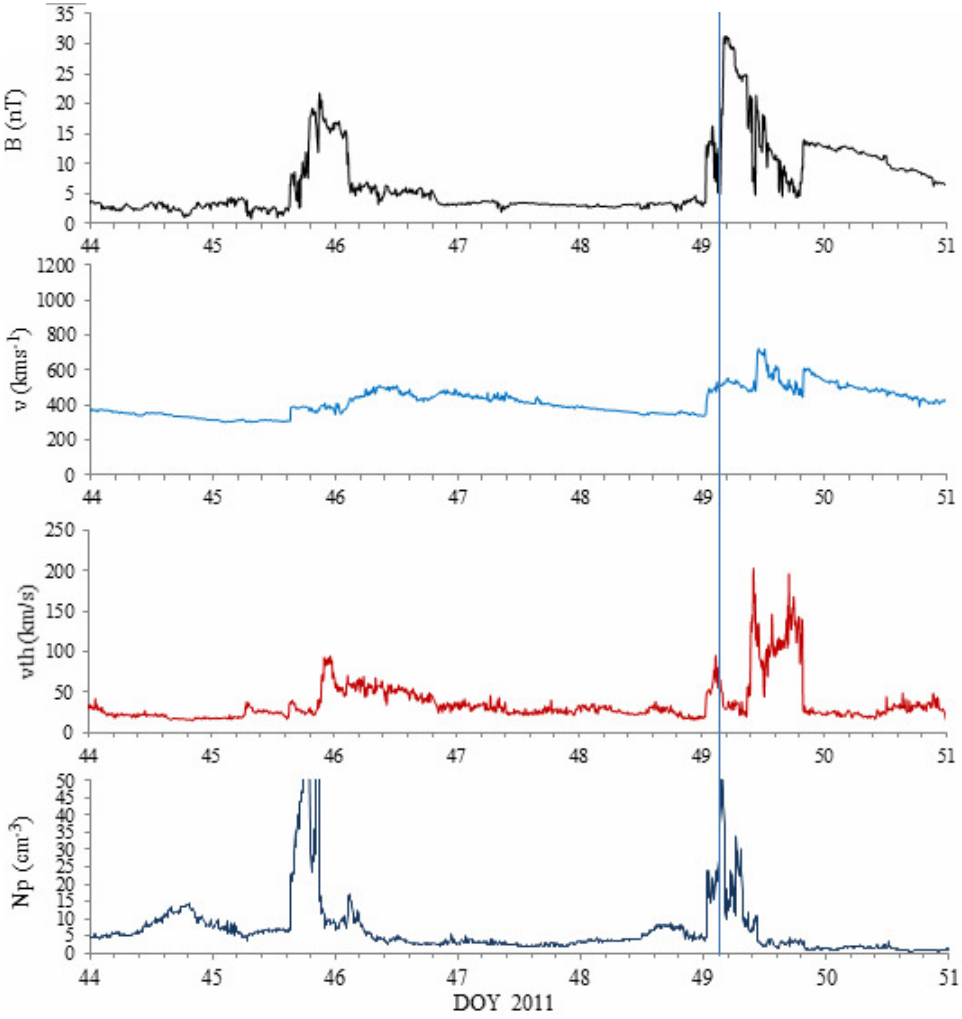


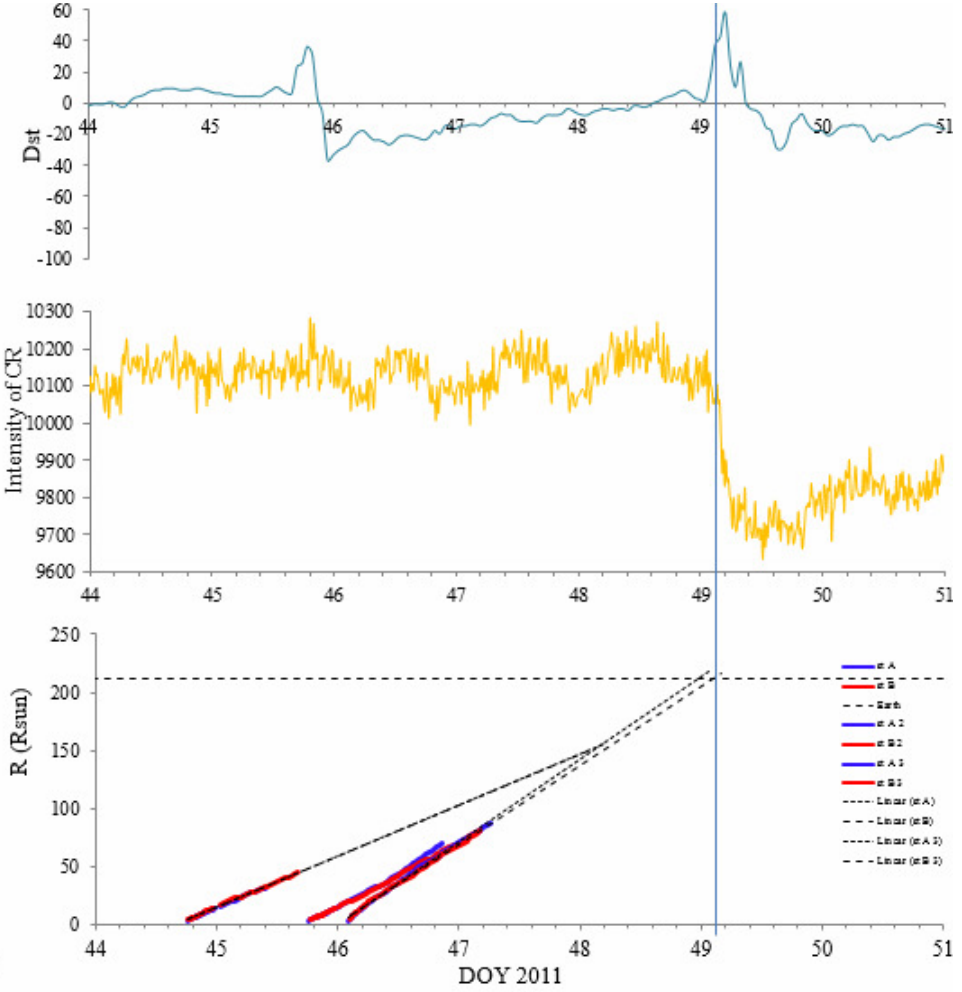
SW and single ICME



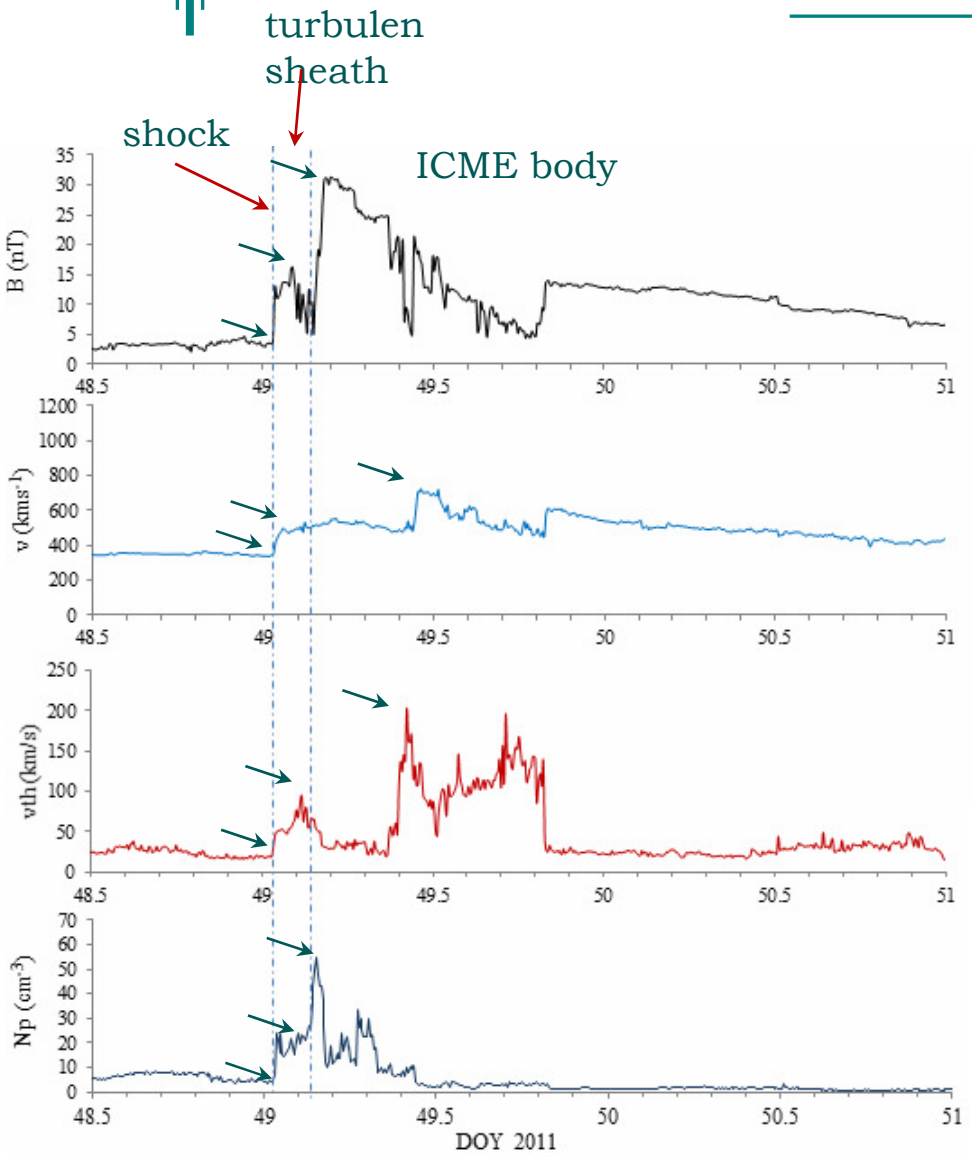
- Form 56 ICME causing 32 solar wind disturbance.
- 18 of them caued by single arriving ICME and 14 by ICMEs interaction

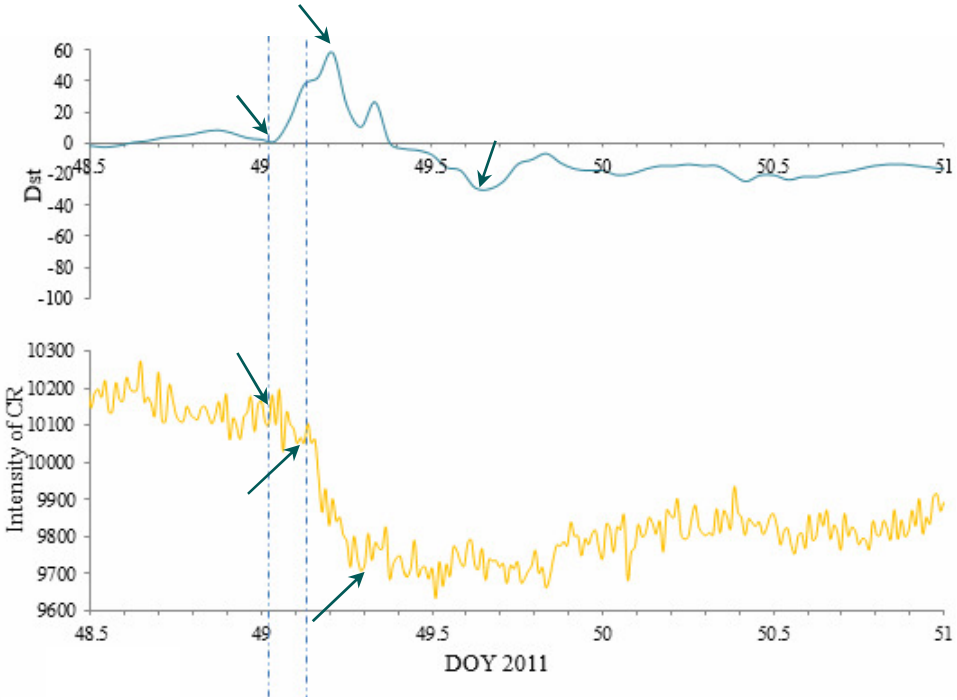
SW and interacting ICMEs





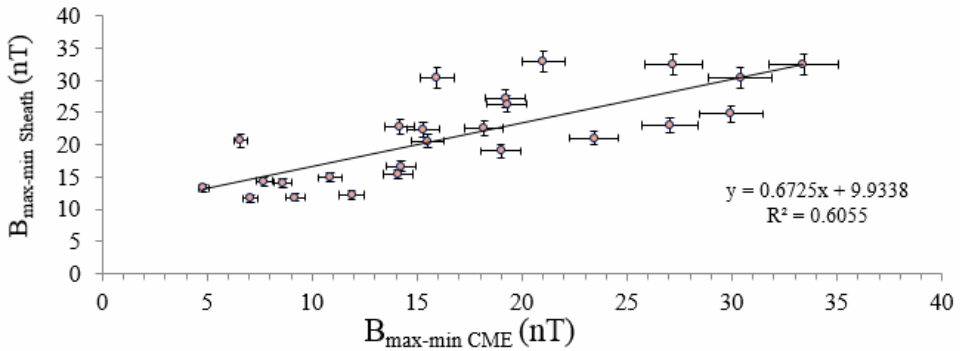
Measured parameters of *in situ*

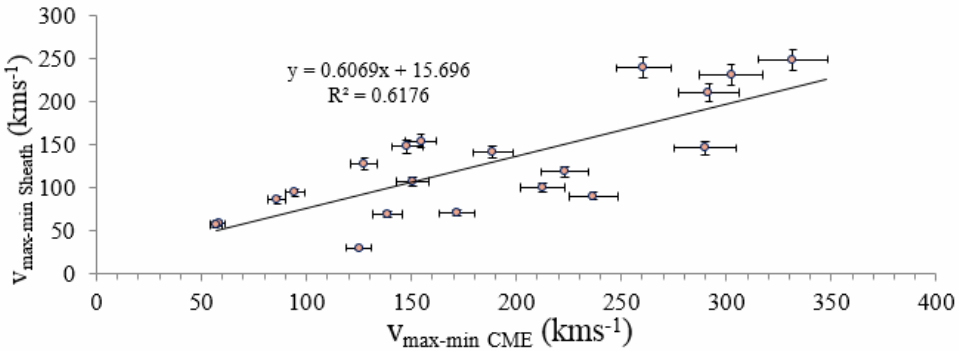


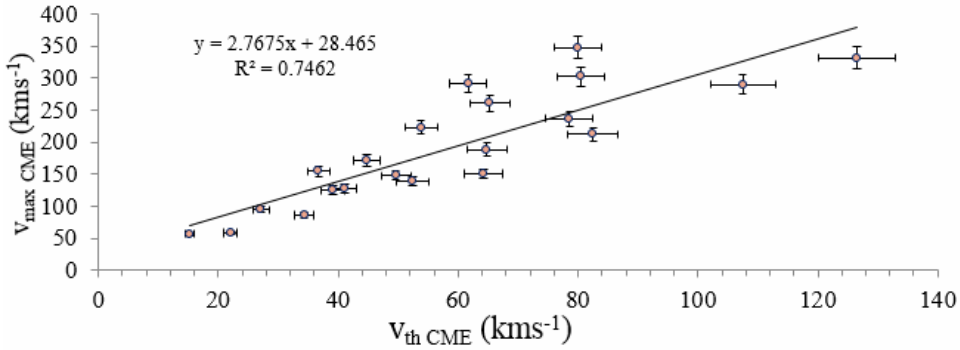


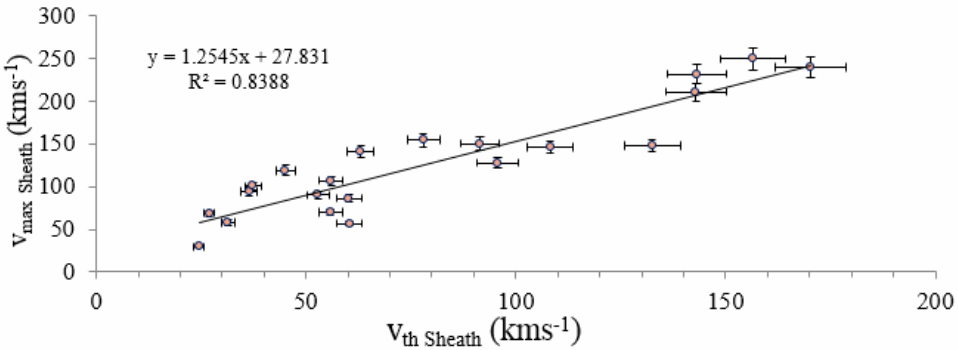
(a) magnetic field strength,
(b) solar-wind speed,
(c) proton thermal velocity,
(d) proton density
(e) Dst index and
(f) neutron cosmic ray intensity

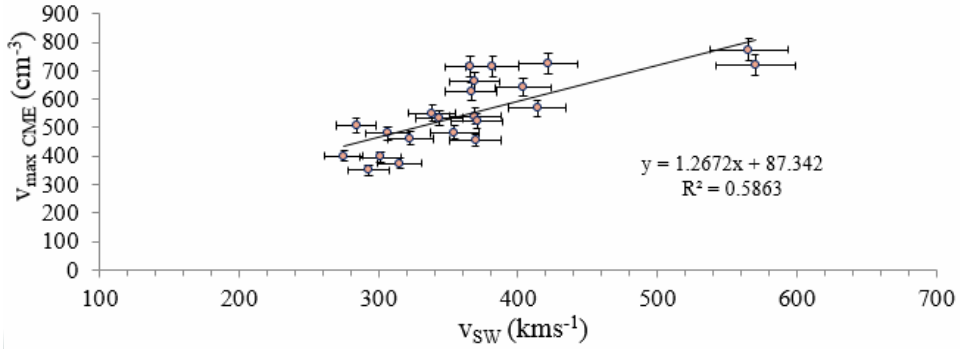
Results – SW parameters

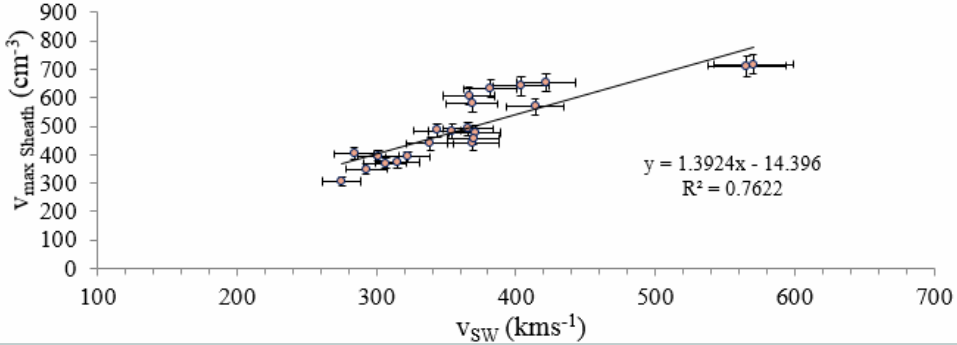




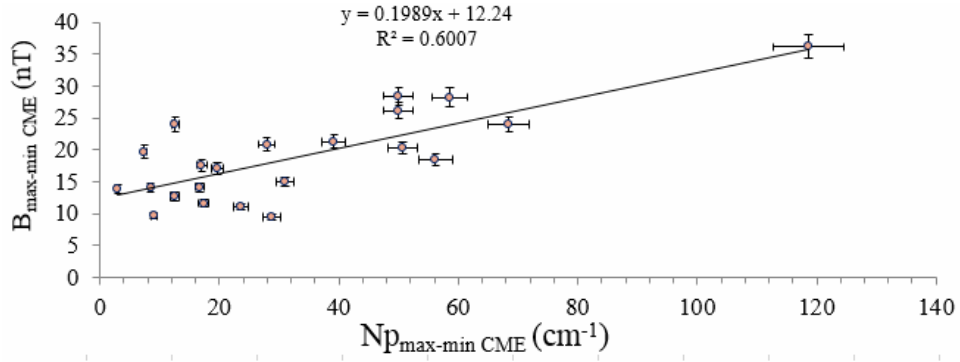


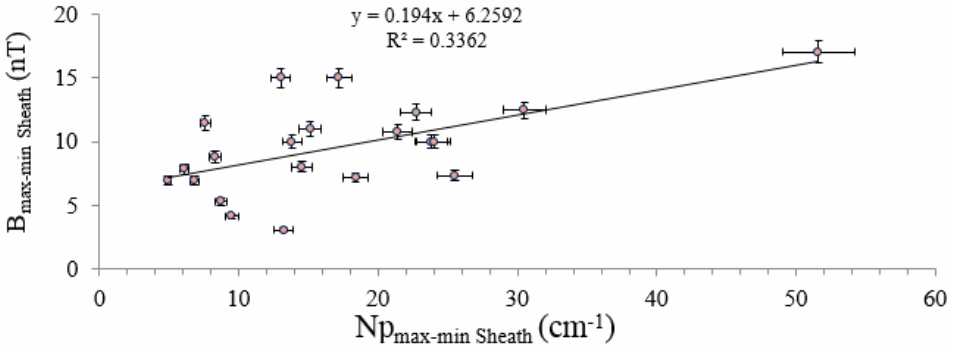


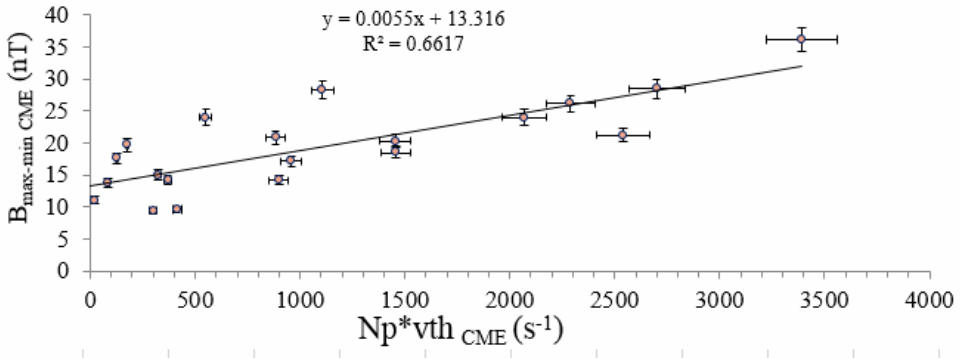


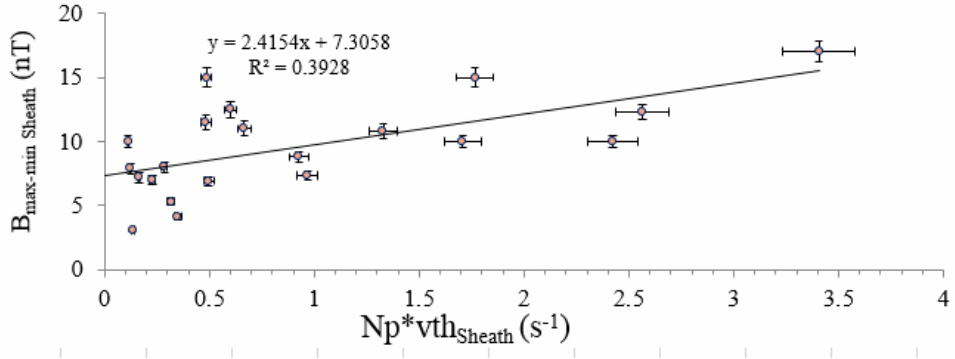


Results – SW parameters



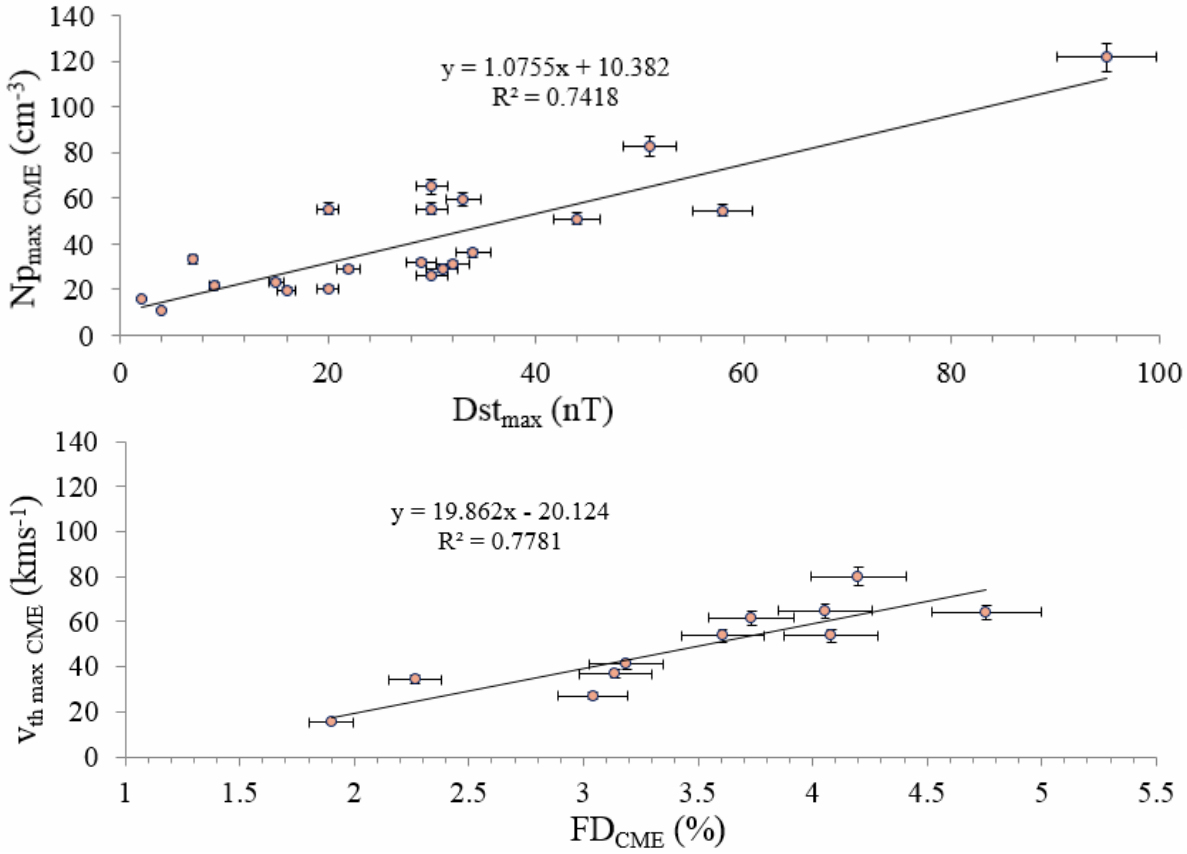






Results – cosmic ray and Dst

no correlation with B and v



Conclusions

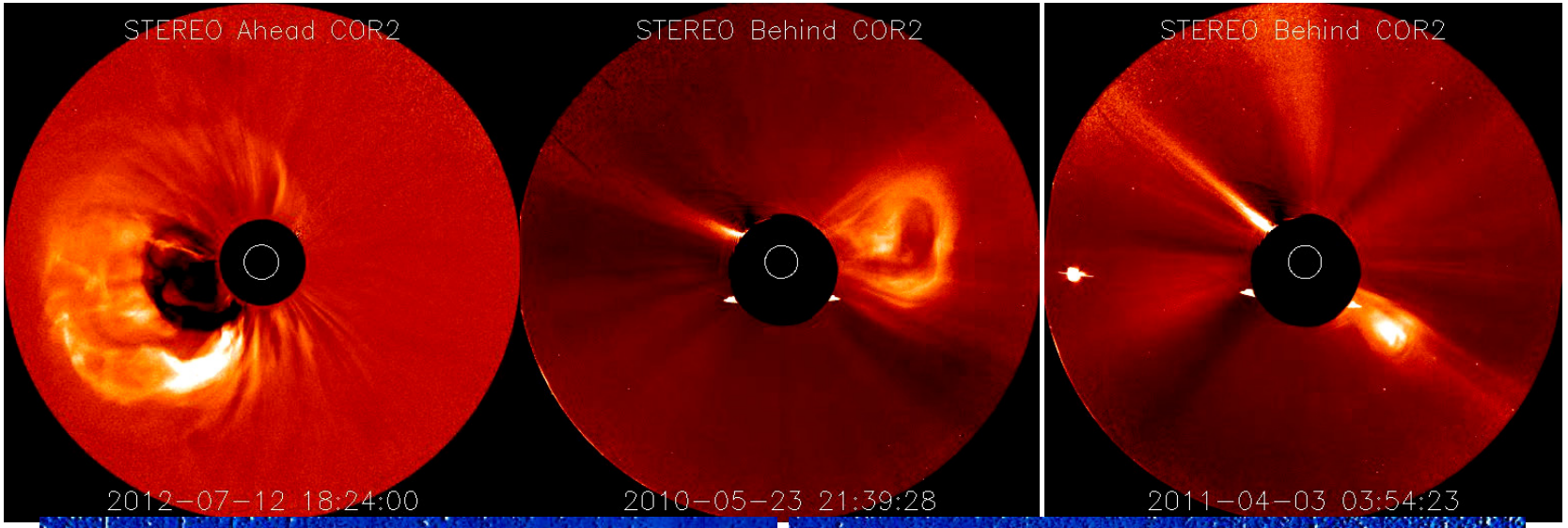
from the analyze of SW disturbances ⇒ we find 216 solar wind disturbances from beginning 2008 to the end of 2013.
search for corresponding ICME ⇒ in analyzed period we recognize 1536 eruption. 301 of the have East direction in STEREO A and W direction in STEREO B satellites.
from the ICMEs kinematics ⇒ we estimated the arrival time of the ICMEs at 1 AU. 186 CMEs can be connected with corresponding SW disturbance.
from analyze of shock ahead ICMEs ⇒ only 56 ICMEs – 32 SW disturbance have shock + ICME structure. 18 are single arriving ICMEs and 14 correspond with interacting ICMEs.

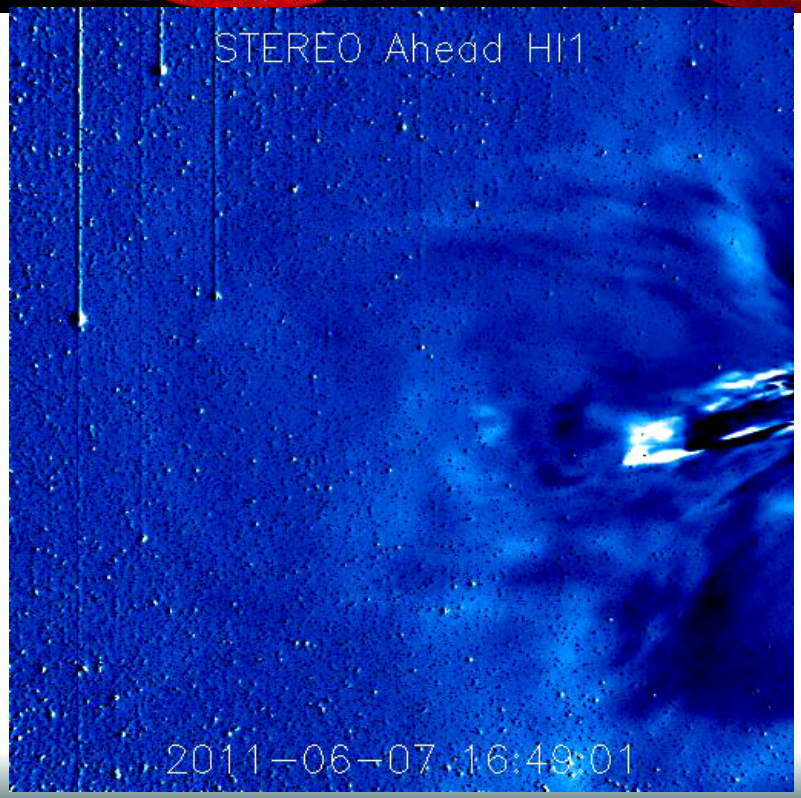
Maximum of the magnetic field strength solar-wind speed and proton thermal speed, in the turbulent sheath and ICME body are high correlate.

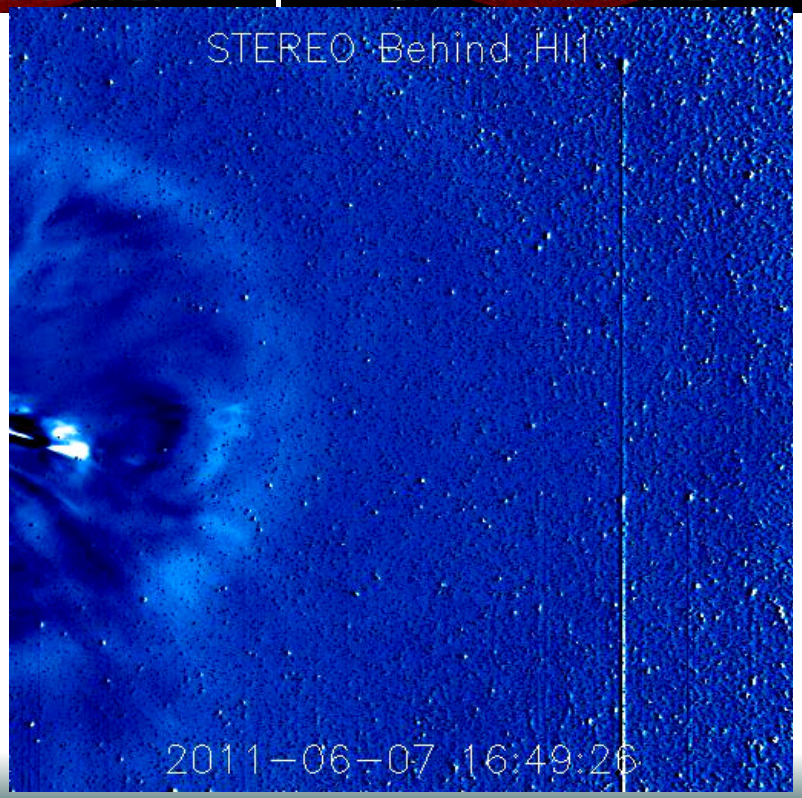
Sped of the solar wind before of ICME arriving show linear relationship with maximum speed in turbulent sheath and ICME body.

There is also correlation, that ICME with stronger magnetic field have higher density.

in future ⇒ tray to analyze other 130 events whose have different signature in solar wind data


STEREO Ahead COR2
2012-07-12 18:24:00
STEREO Behind COR2
2010-05-23 21:39:28
STEREO Behind COR2
2011-04-03 03:54:23


STEREO Ahead HI1
2011-06-07 16:49:01


STEREO Behind HI1
2011-06-07 16:49:26

prominence signatures