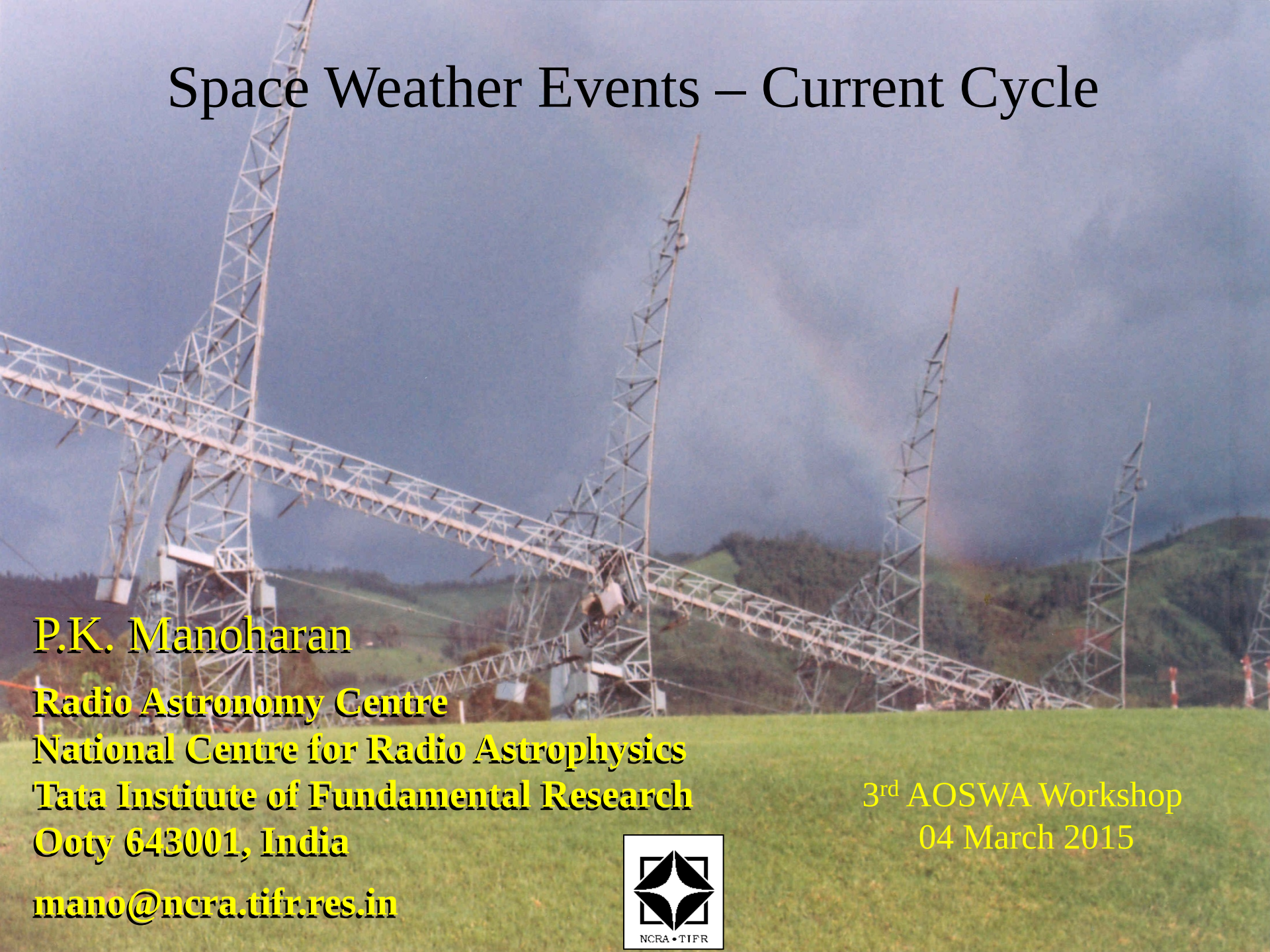
# Space Weather Events – Current Cycle



P.K. Manoharan

**Radio Astronomy Centre**
**National Centre for Radio Astrophysics**
**Tata Institute of Fundamental Research**
**Ooty 643001, India**

**mano@ncra.tifr.res.in**

3rd AOSWA Workshop
04 March 2015

# Fast Energetic CMEs

# 12 – 23 July 2012

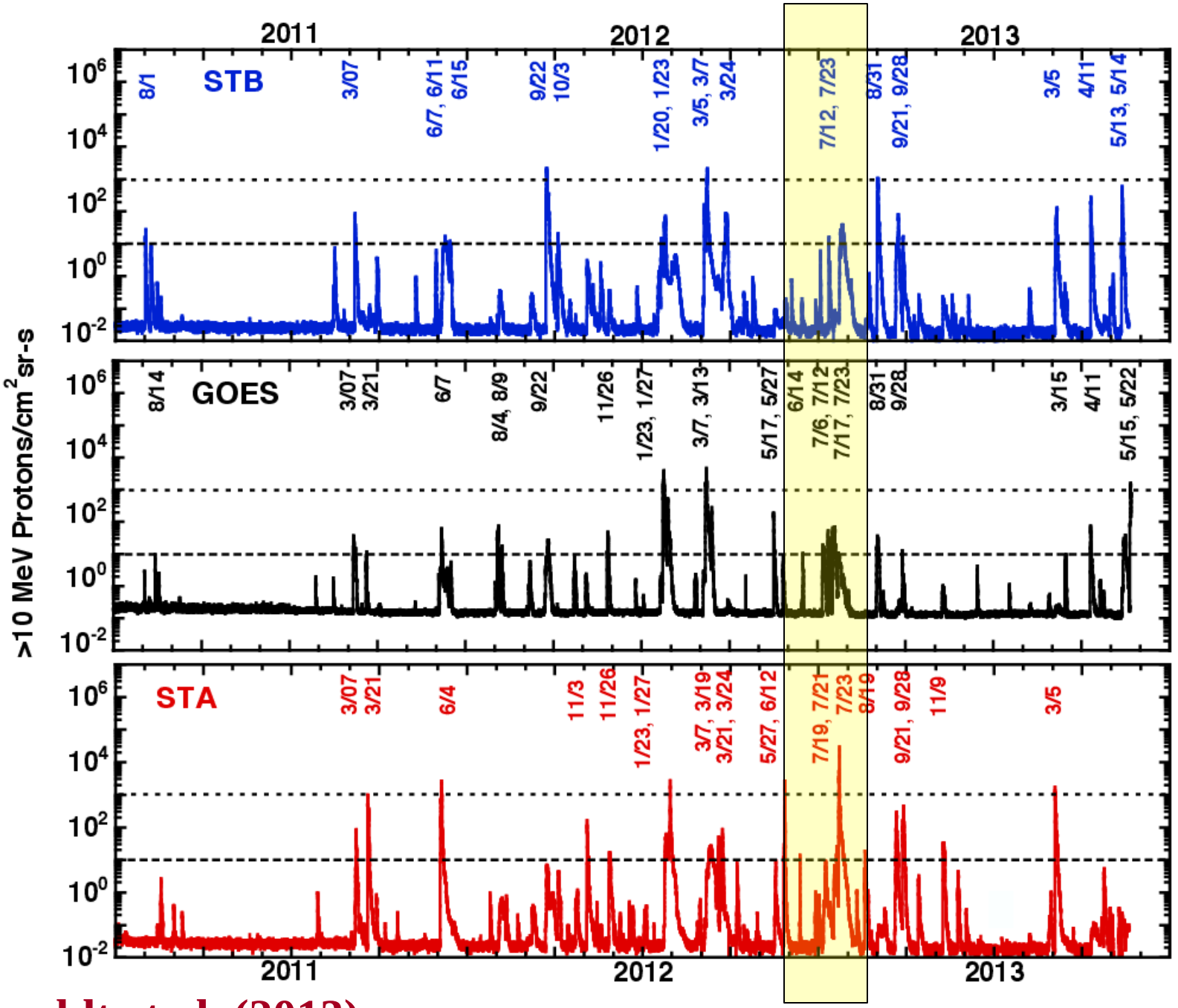
# July 2012 Events

## AR 1520 produced several flares and associated CMEs

- 12 July 2012 – close to the disk center disk X1.4 S17W08; H CME at 16:48 UT – LASCO speed at 10 Run ~1050 km/s;
- 17 July 2012 – M1.7 at S28W65; PH CME at 13:48 UT 958 km/s
- 18 July 2012 – S14W88; H CME 873 km/s nearly constant speed
- 19 July 2012 – M7.7 S13W88; H CME at 05:24 UT 1631 km/s
- 23 July 2012 – associated with an estimate of M8 – X2.5 flare event; location ~W133 degree; SRA located at 121 degree reasonably well located to observed the CME

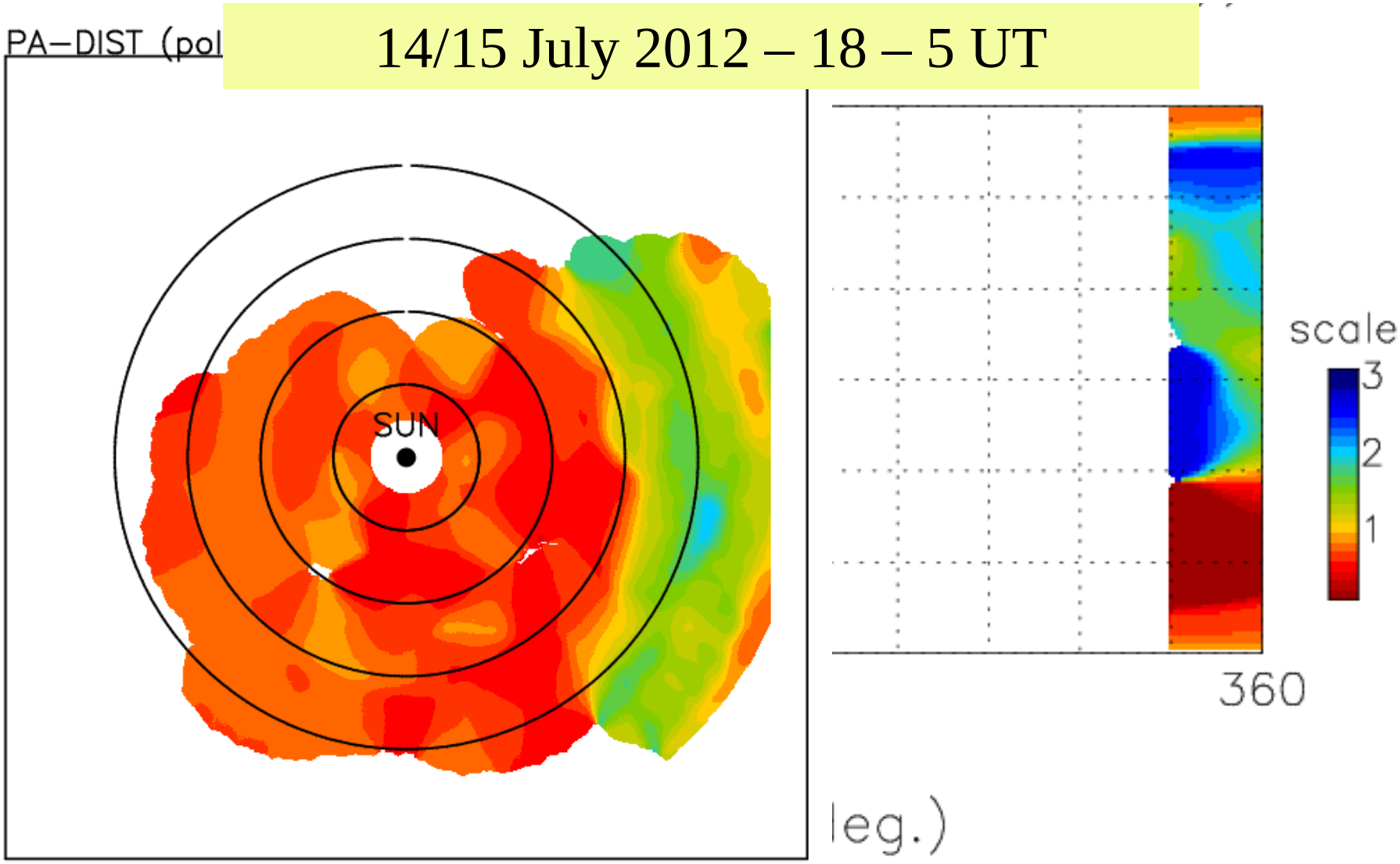
# July 2012 events have been studied by …

- Baker et al., Space Weather (2013)
- Ngwira et al., Space Weather (2013)
- Mewaldt et al., ICRC (2013)
- Liu et al., Nature Communications (2014)
- Hess and Zhang, ApJ (2014)
- Gopalswamy et al., Earth, Planets, and Space (2014)
- Several groups are working on observed data plus on modeling aspects

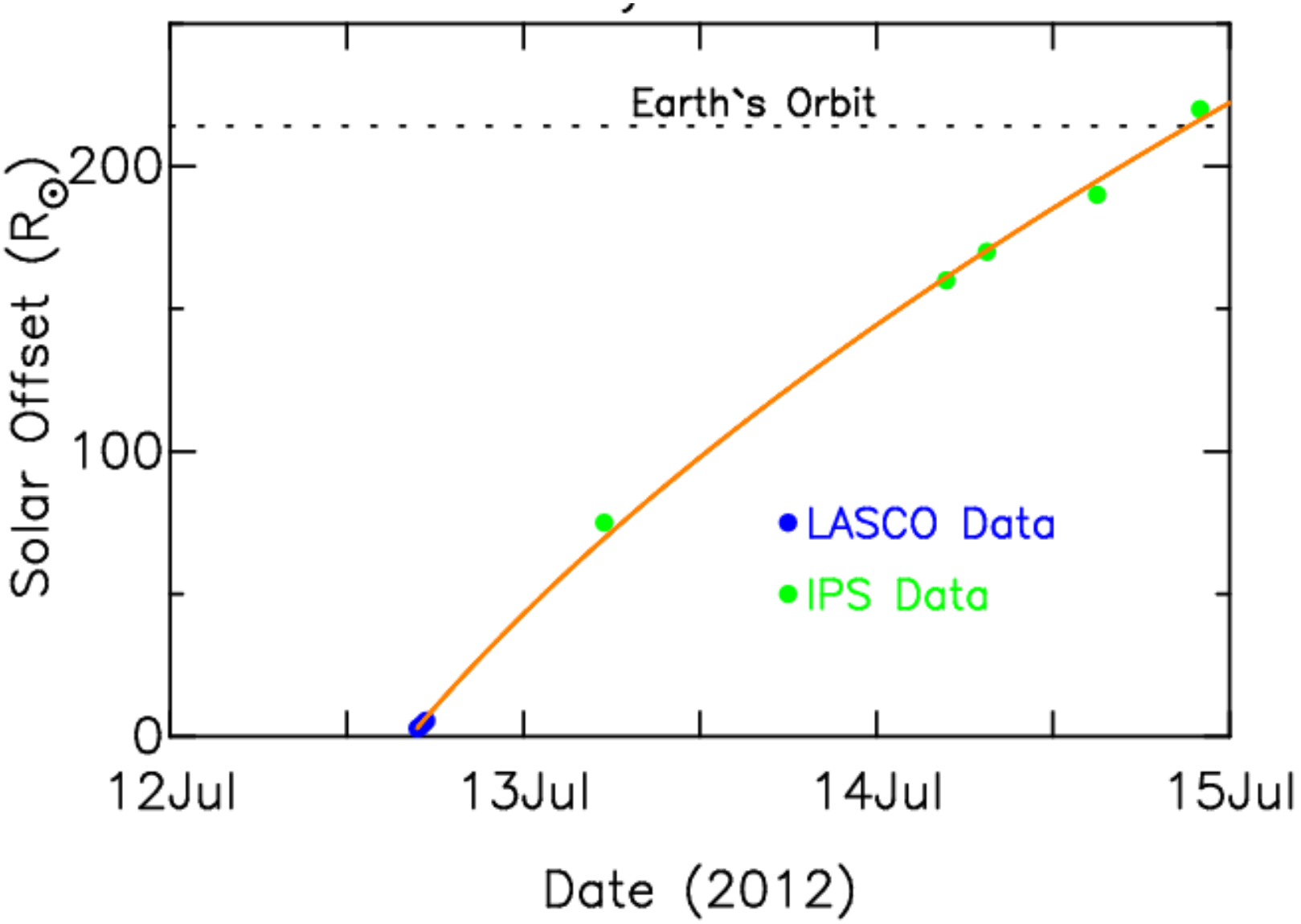



**Mewaldt et al. (2013)**

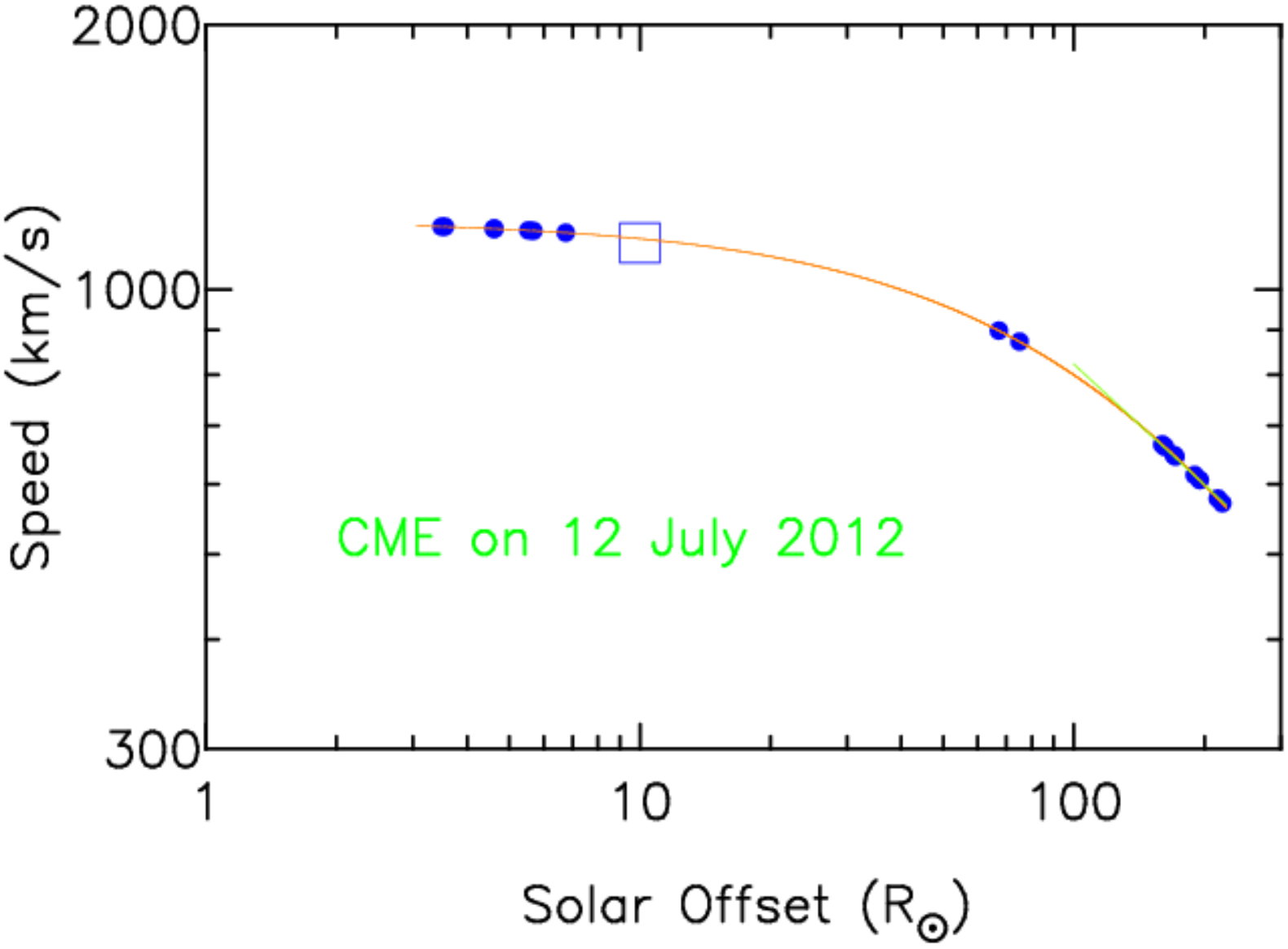
# CME event on July 12, 2012



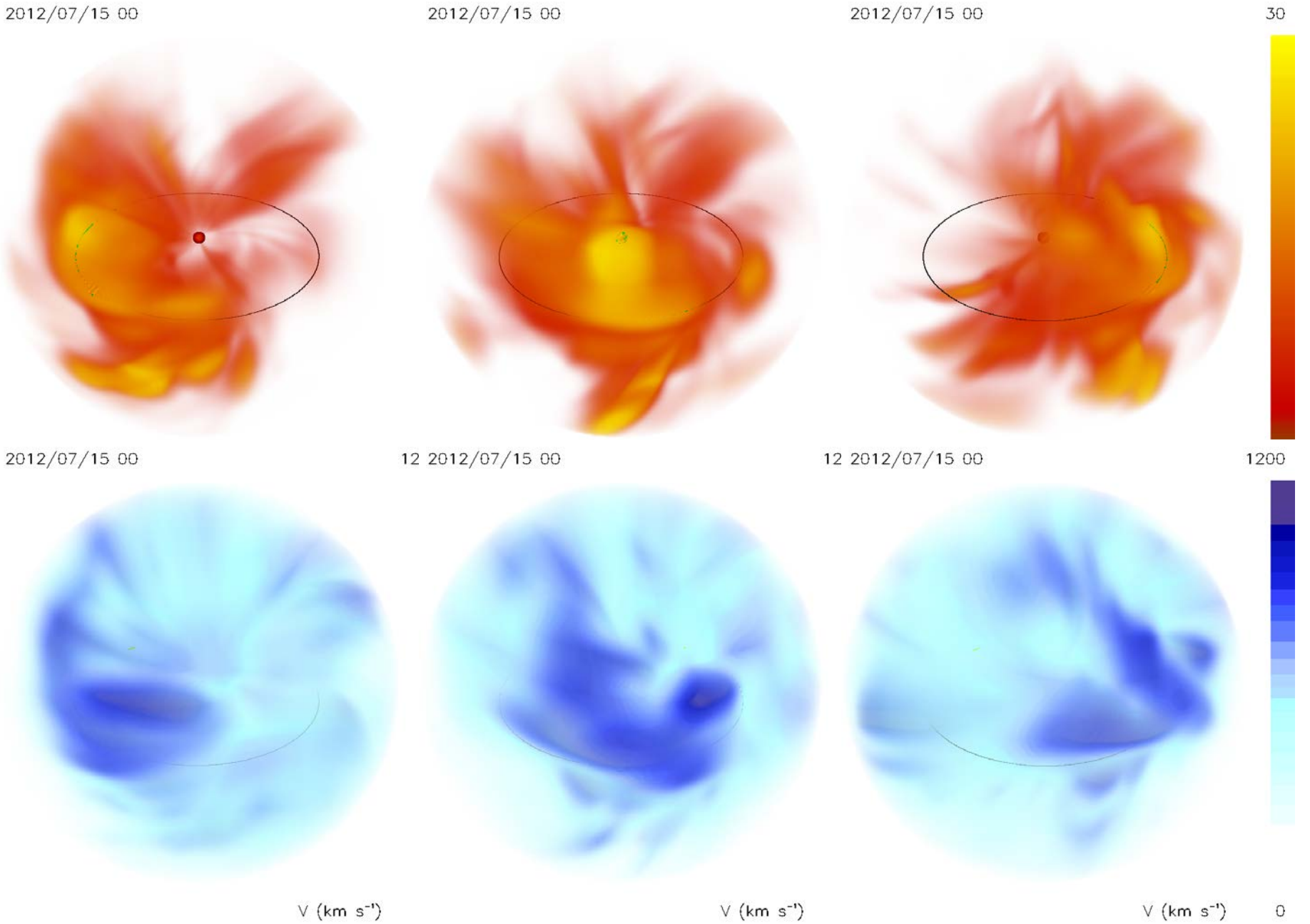
# CME event on July 12, 2012



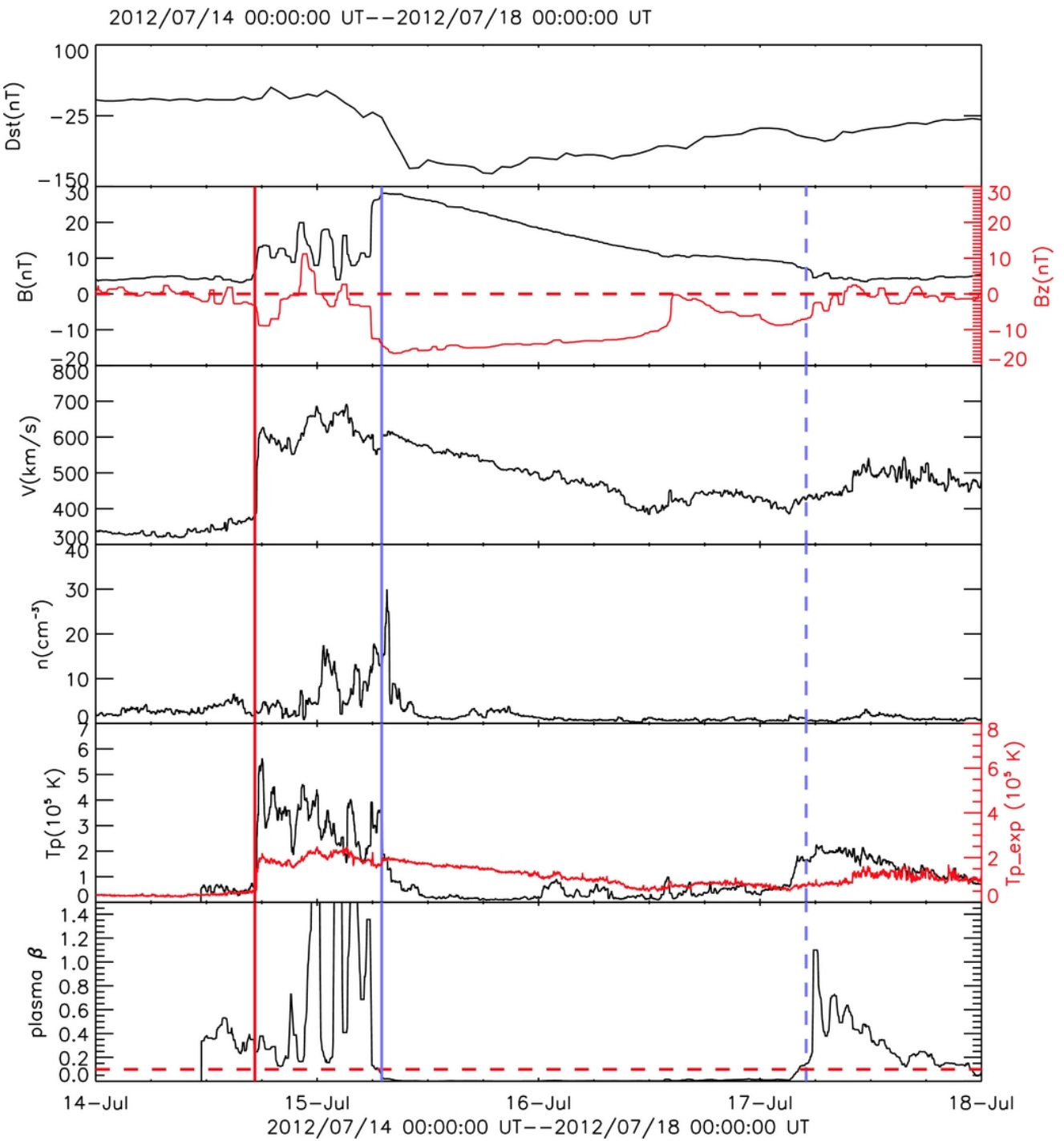
# CME event on July 12, 2012



# Density and Speed – 3D Reconstructions

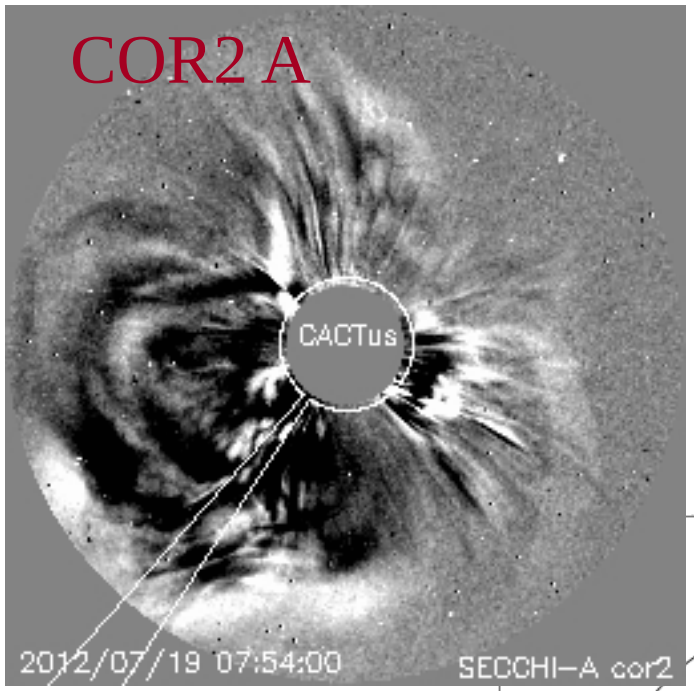


12 July 2012CME

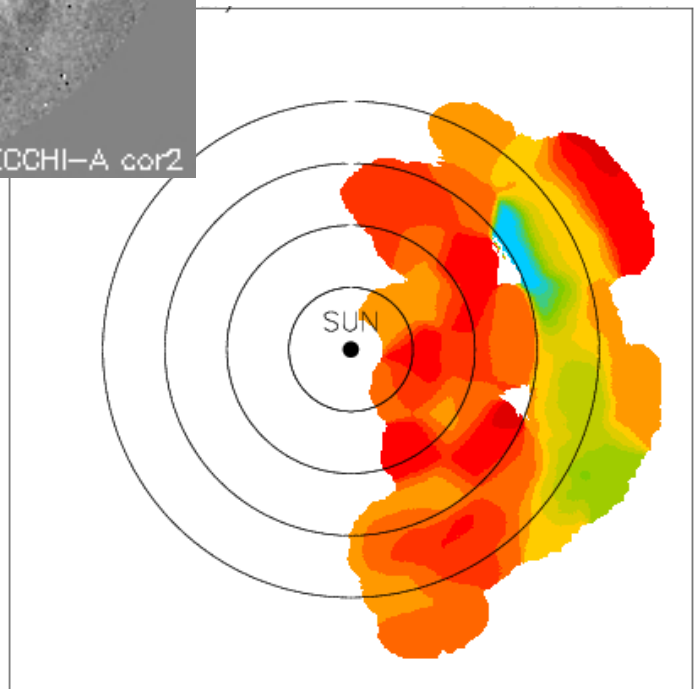



**Hess and Zhang (2014)**

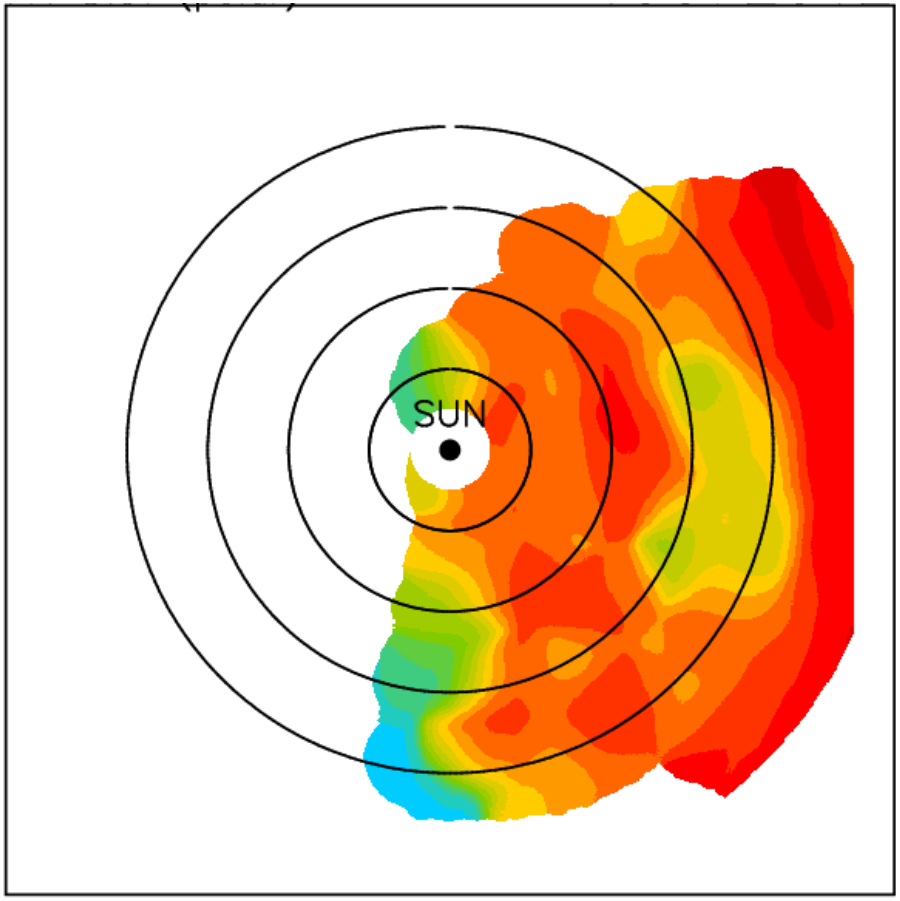
# Fast CME on July 19, 2012

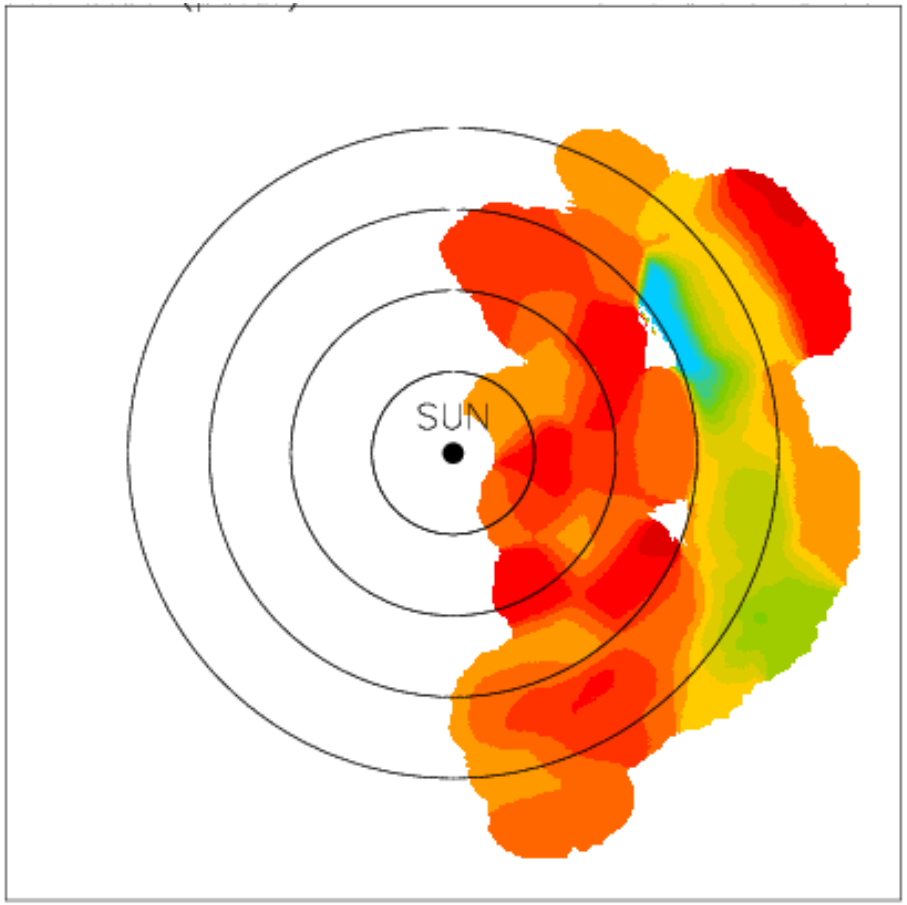

Ooty IPS image on 21 July, ~0 UT



# CMEs – July 17 - 19, 2012 – IPS Images

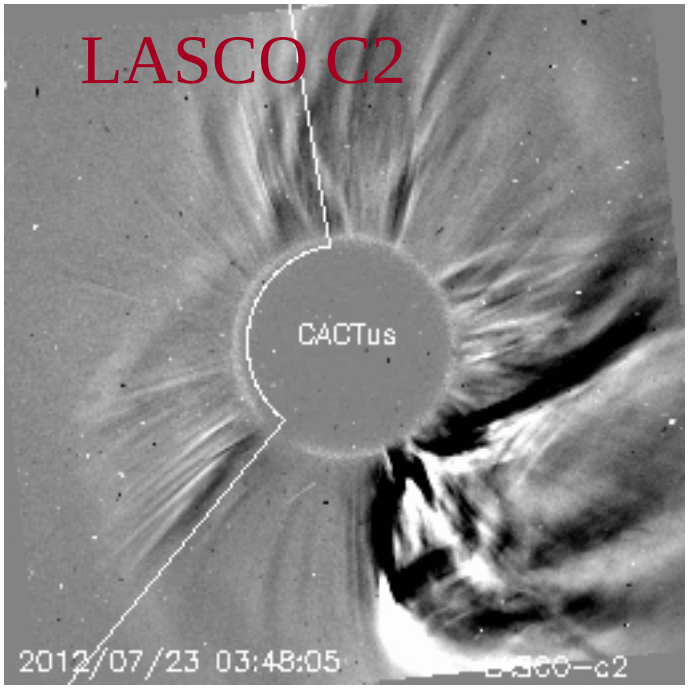


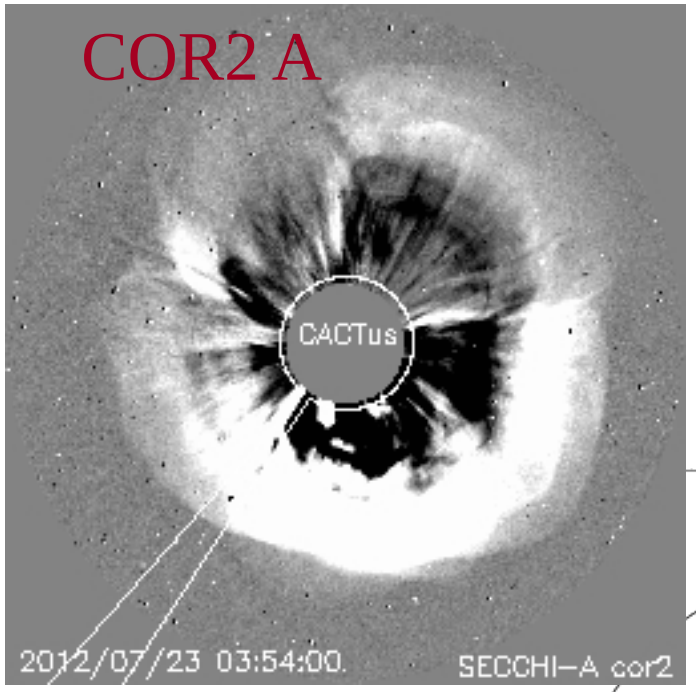

20 July, ~0 UT

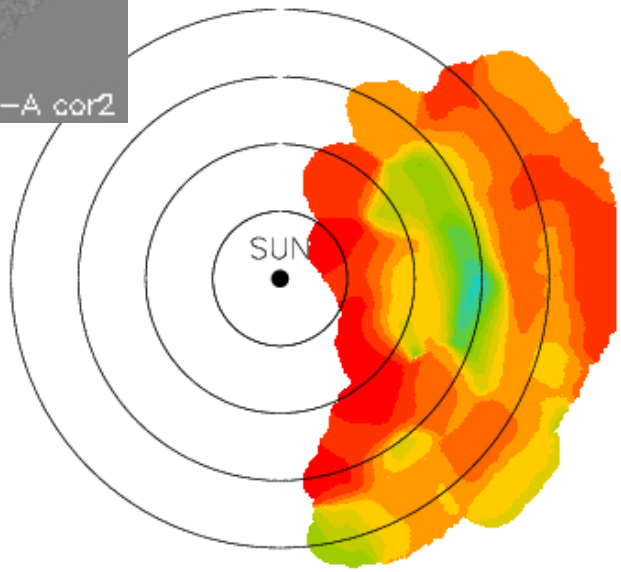



21 July, ~0 UT

# Fast CME on July 23, 2012

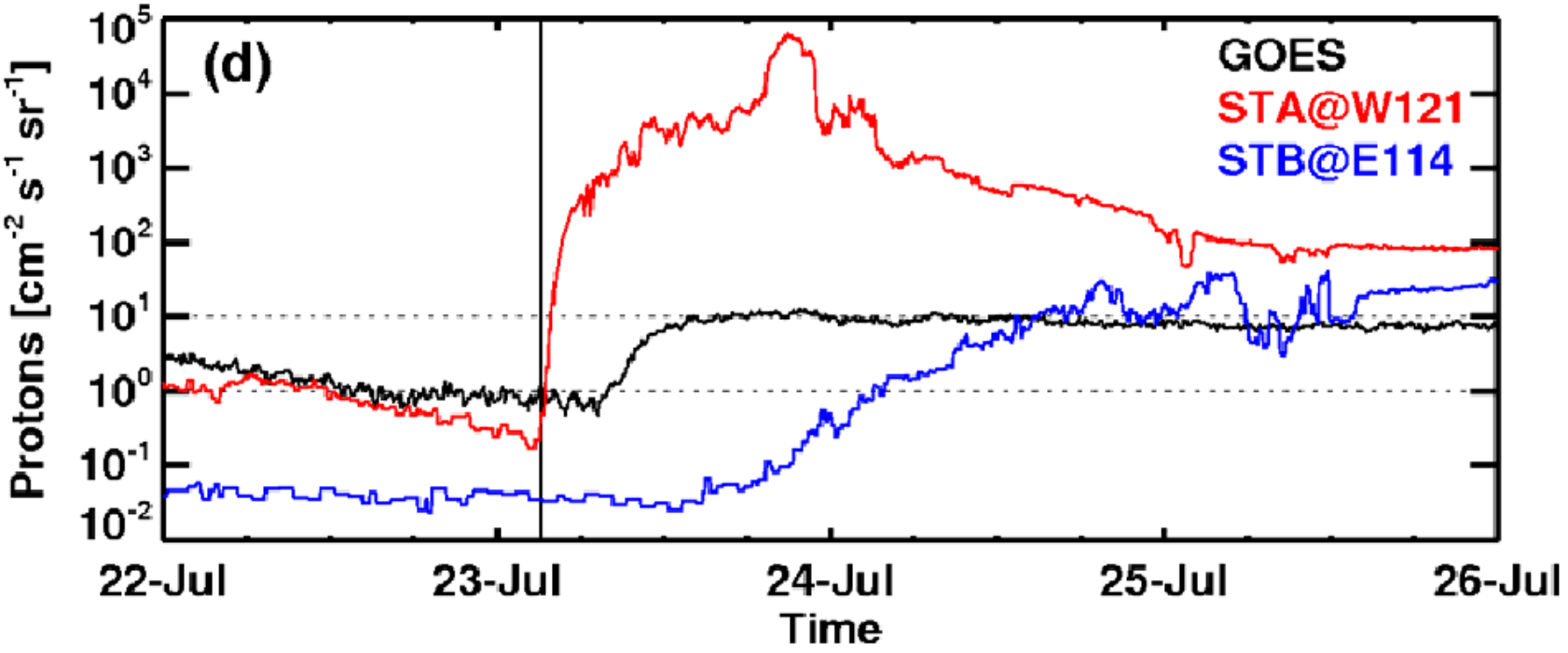


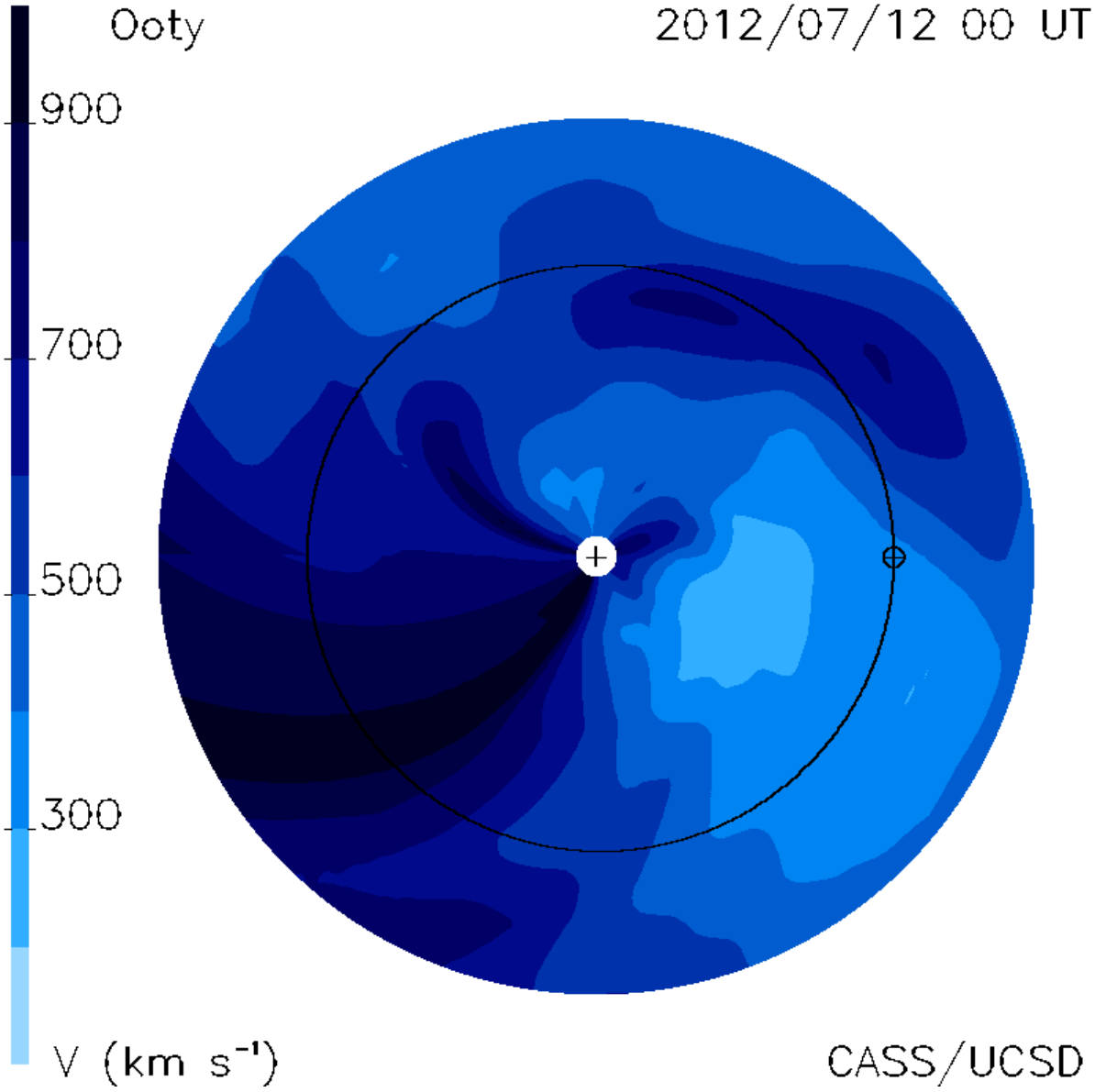

Ooty IPS image on 23 July, ~20 UT

# CME on July 23, 2012




**Gopalswamy et al. (2014)**

# Ooty IPS – Solar Wind Speed



# July 2012

In IPS measurements, we could identify CMEs structures and track them

12 July 2012

- For this event, the propagation of the CME was close to the Sun-Earth line; however. the eastern part seems to travel bit faster than the center or western parts.

17 – 19 July 2012 CMEs

- CME on 19 July interacts with preceding CME(s?)

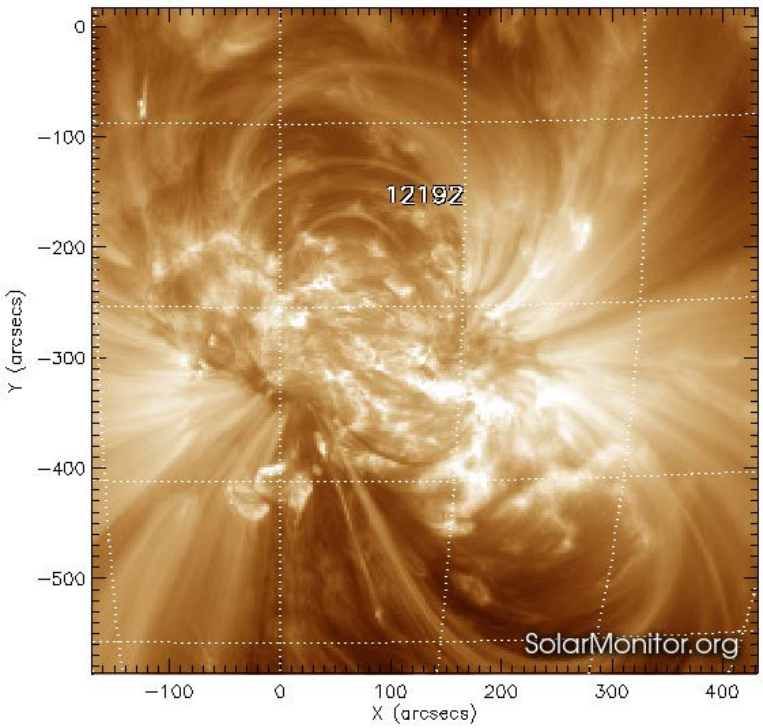
# July 2012 cont.

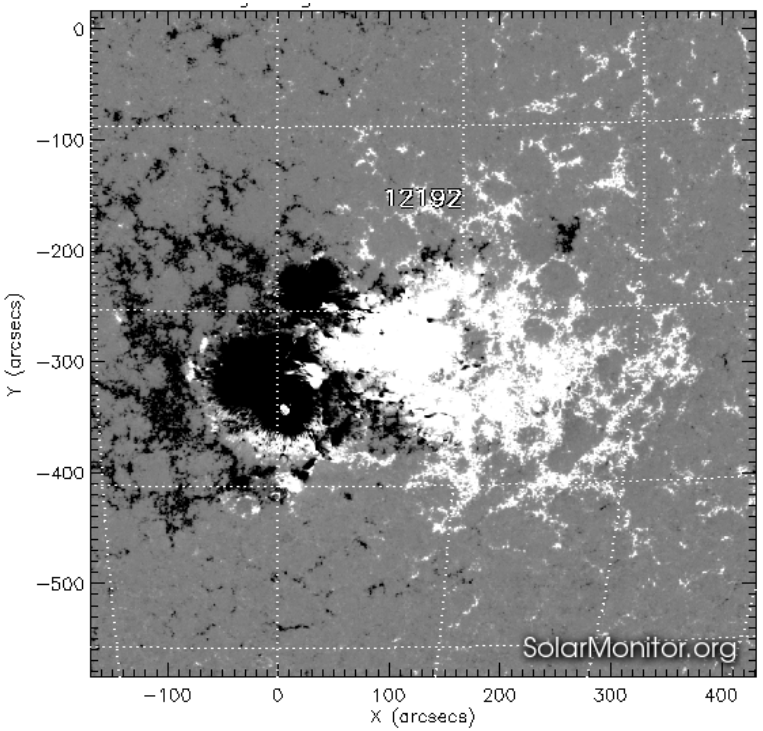
## 23 July 2012

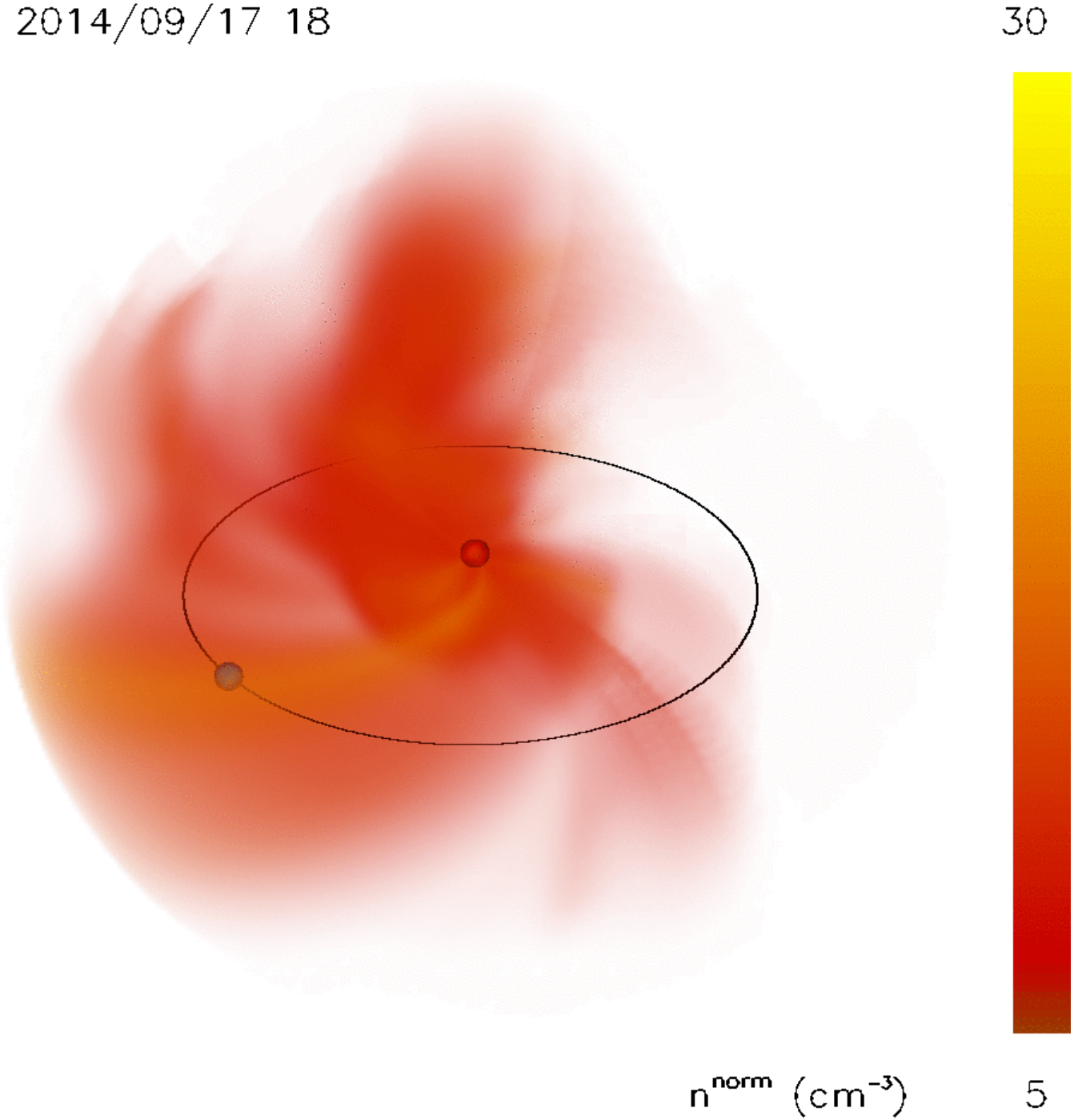
- The CME width as seen by IPS seems to be narrow up to ~1 AU and expands rather fast after 1 AU!
- A sharp increase in speed seen at the shock front; ICME moves with a speed of ~1500 km/s

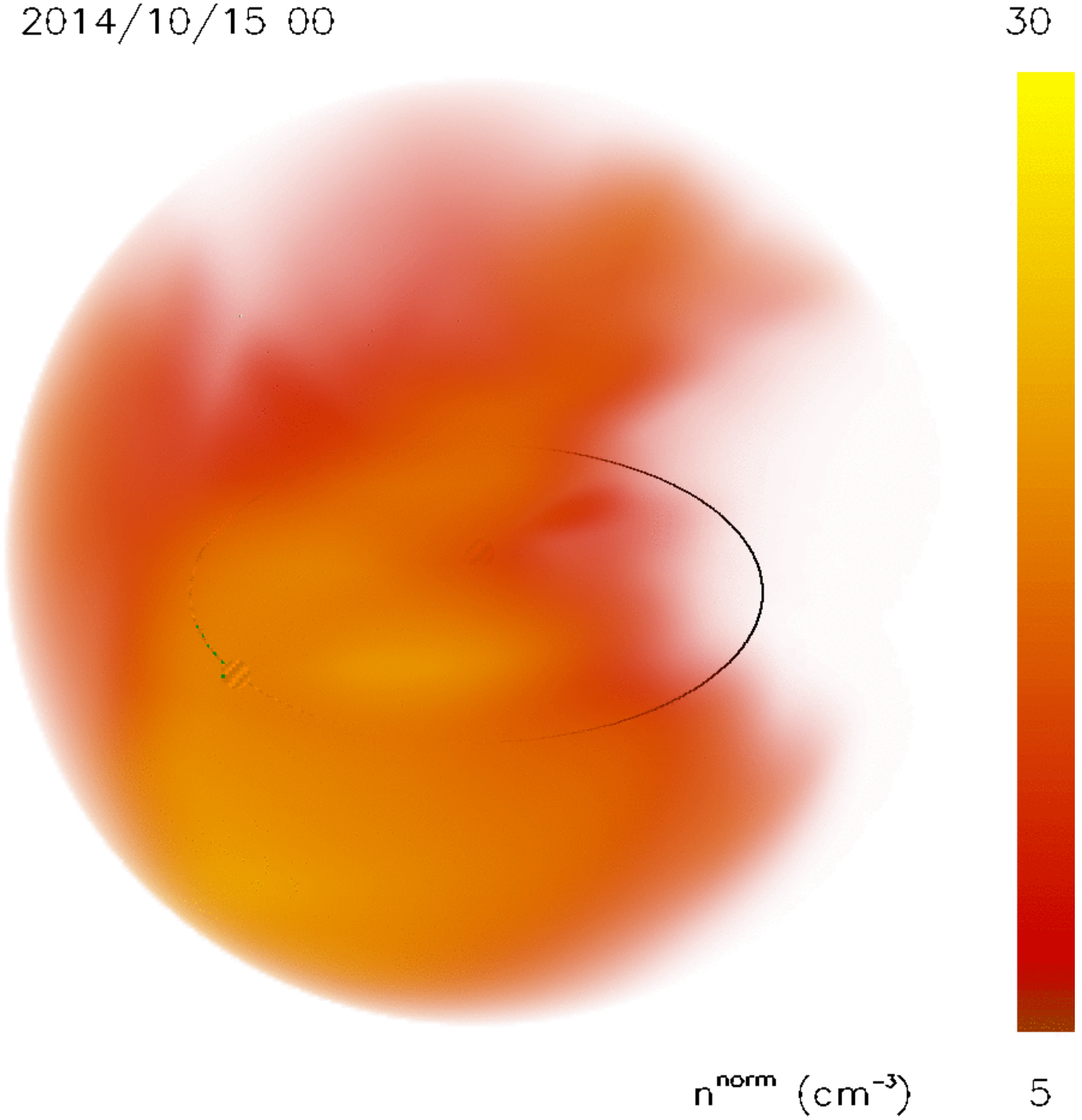
# Active Region AR 12192 (12173/12209)

- Large in area
- βγδ magnetic configuration
- Produced several intense flares (X and M-class flares)
- Associated moderate CMEs



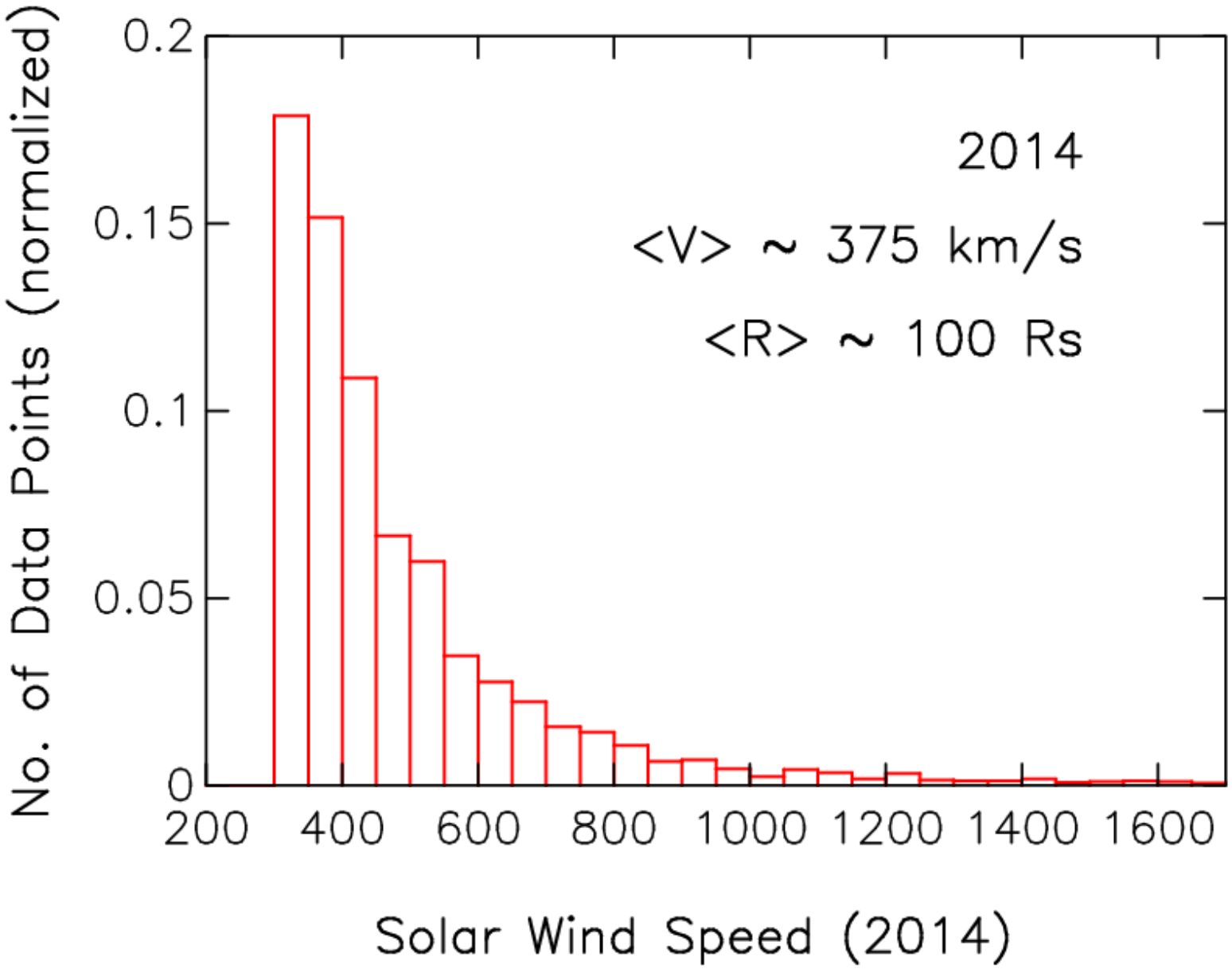



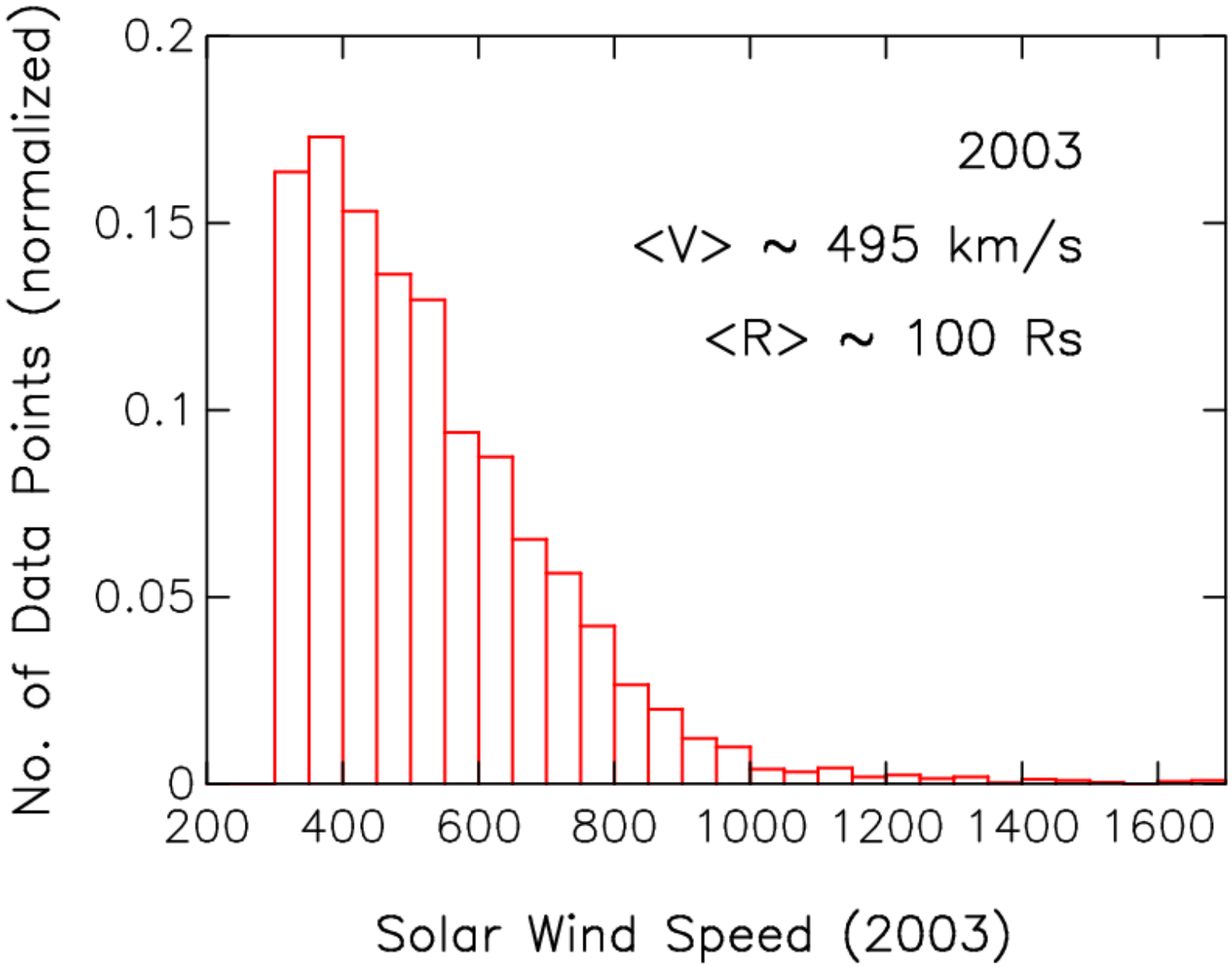

2014/09/17 18
30
$n^{norm}$ $(cm^{-3})$
5

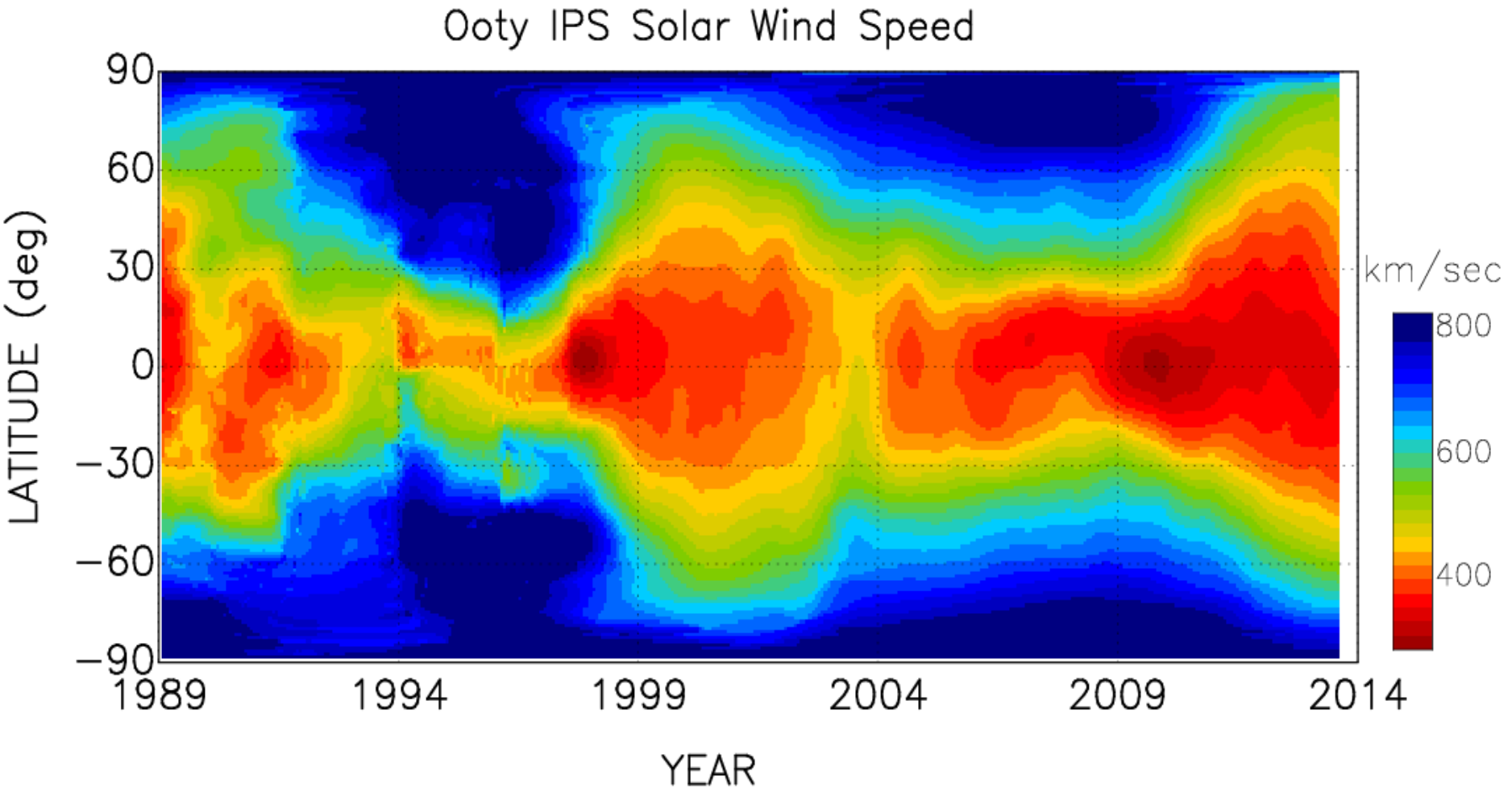

2014/10/15 00
30
$n^{norm}$ $(cm^{-3})$
5

# September – October 2014

Spatial expansion of CMEs seems to be quick within 50 Rs!?


No. of Data Points (normalized)
0.2
0.15
0.1
0.05
0
200
400
600
800
1000
1200
1400
1600
Solar Wind Speed (2014)
2014
<V> ~ 375 km/s
<R> ~ 100 Rs


2003
<V> ~ 495 km/s
<R> ~ 100 Rs
No. of Data Points (normalized)
0.2
0.15
0.1
0.05
0
200
400
600
800
1000
1200
1400
1600
Solar Wind Speed (2003)


Ooty IPS Solar Wind Speed
LATITUDE (deg)
90
60
30
0
−30
−60
−90
1989
1994
1999
2004
2009
2014
YEAR
km/sec
800
600
400

# September – October 2014

- No large or intense shock
- Intense flares/CMEs could not cause storms
- Low-speed ambient wind tends to slow down CMEs?
- missing large particle events?

Thank You