Kinematics of Coronal Mass Ejections in the LASCO field of view

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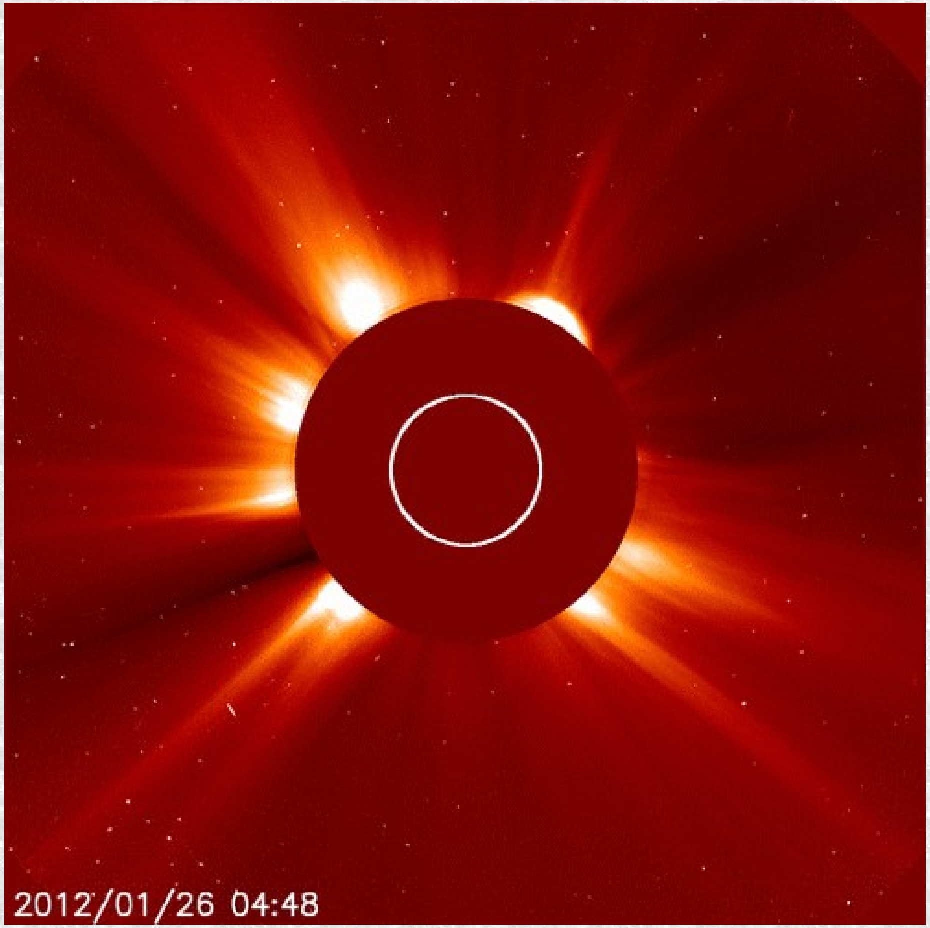
Coronal Mass Ejections

- A coronal mass ejection (CME) are huge expulsions of magnetized plasma from the solar atmosphere.

- Great advances have been made in understanding CMEs by SOHO, Wind, ACE and the latest STEREO mission, to learn their 3D structure.



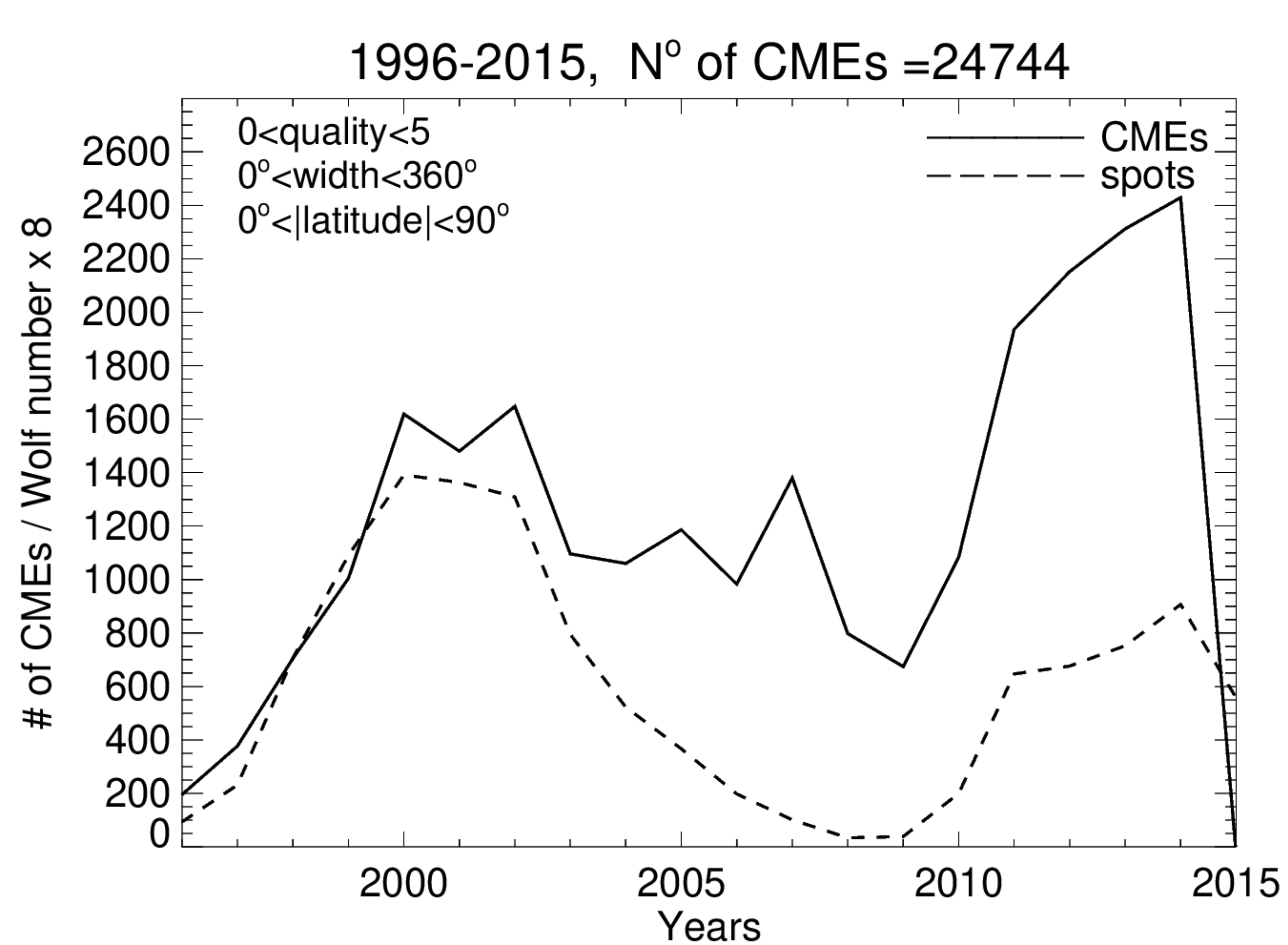
Gif: SOHO LASCO C2 coronograph

SOHO LASCO

- **SO**lar and **H**eliospheric **O**bservatory (**SOHO**) carries **L**arge **A**ngle **S**pectrometric **C**oronograph (**LASCO**) onboard. Launched in 1995 and has recorded ~ 30,000 CMEs till now.

- Field of View of LASCO,C2 and C3 is 2 - 32 solar radius.

- Observations obtained from 1996 to Oct 2017,i.e., 23 and 24 solar cycle.



Data

- **Aim:** to study the acceleration and velocity profiles of CMEs near the Sun, up to ≈ 30 solar radius using SOHO/LASCO catalog.
- The velocity and acceleration was obtained by fitting a straight and quadratic line to all the height-time data.

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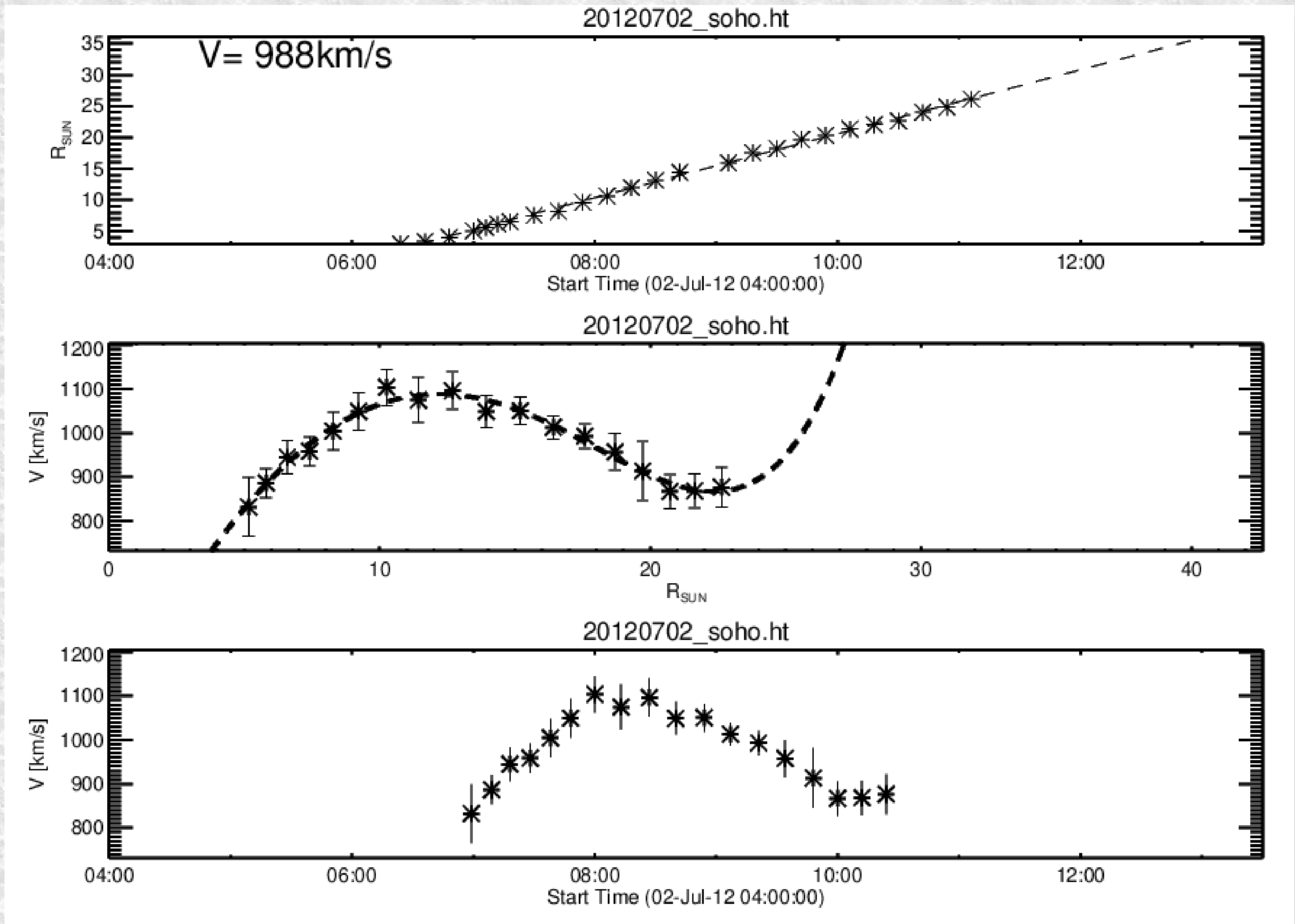
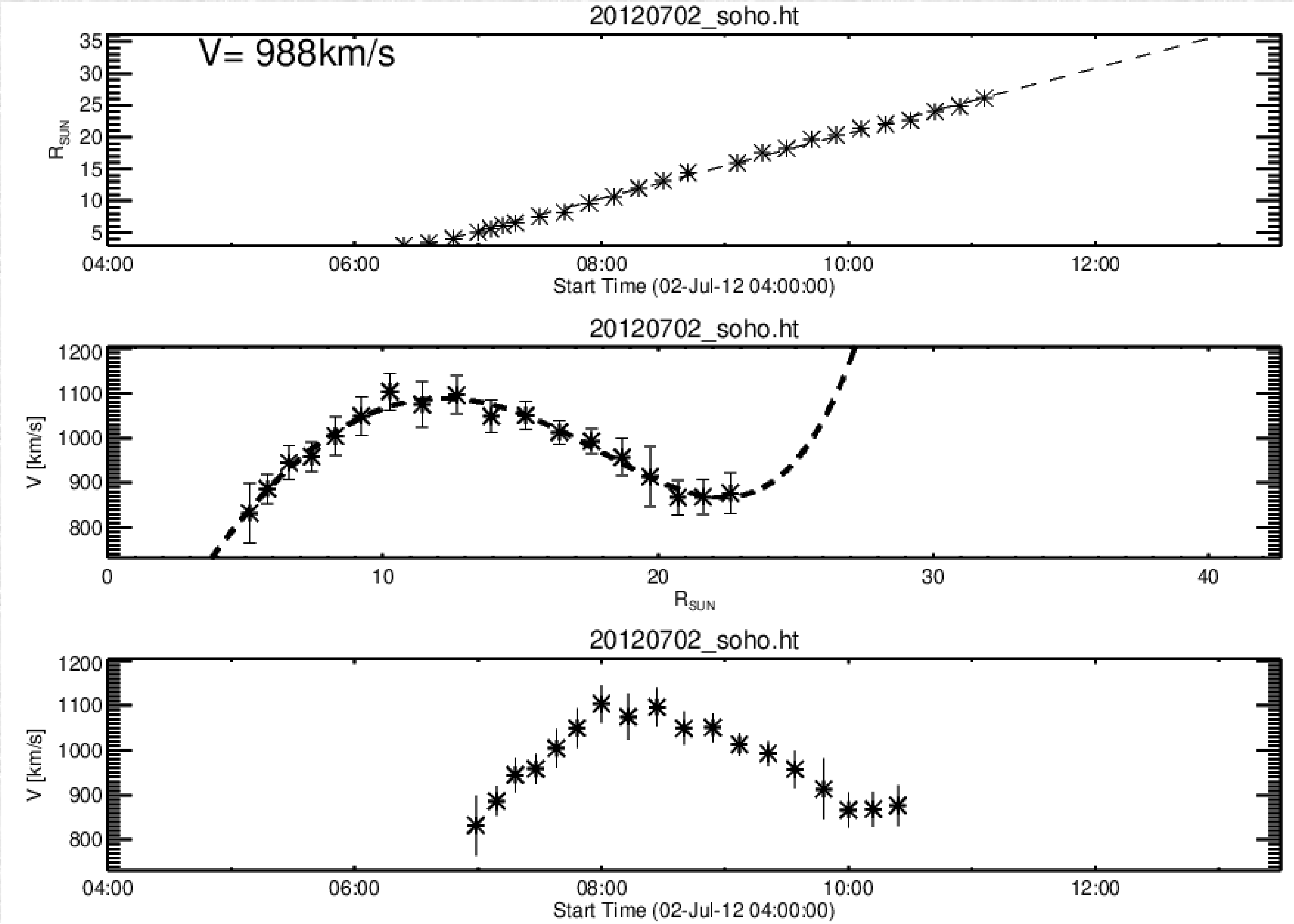
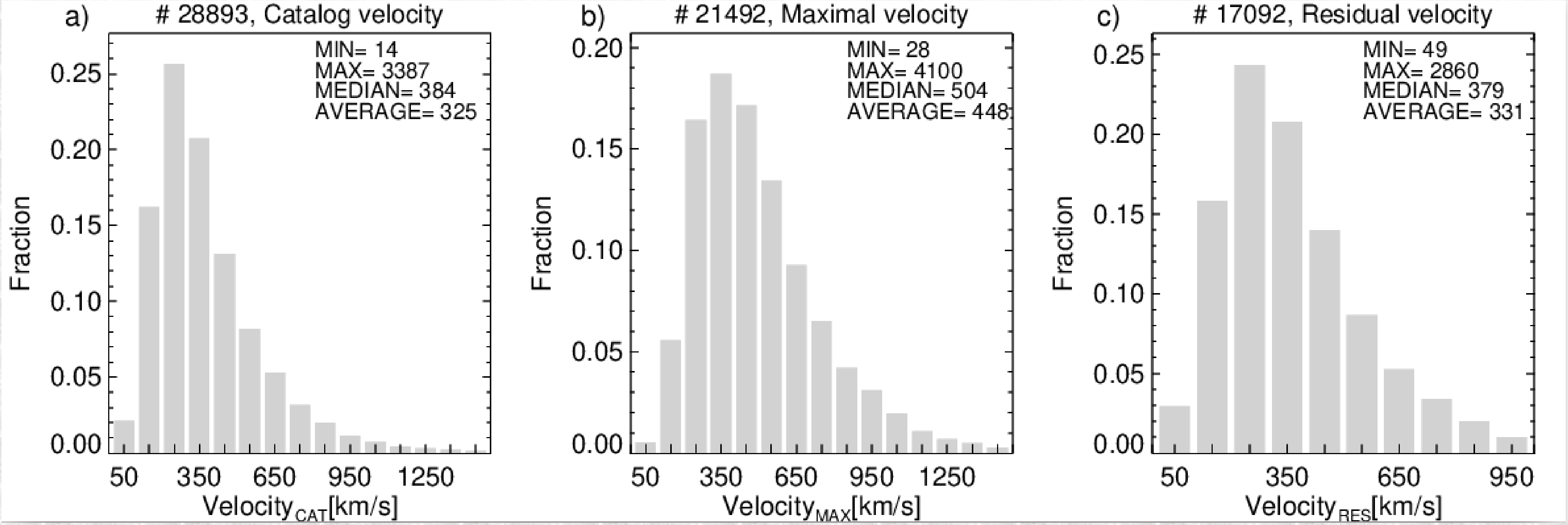


Initial and residual acceleration

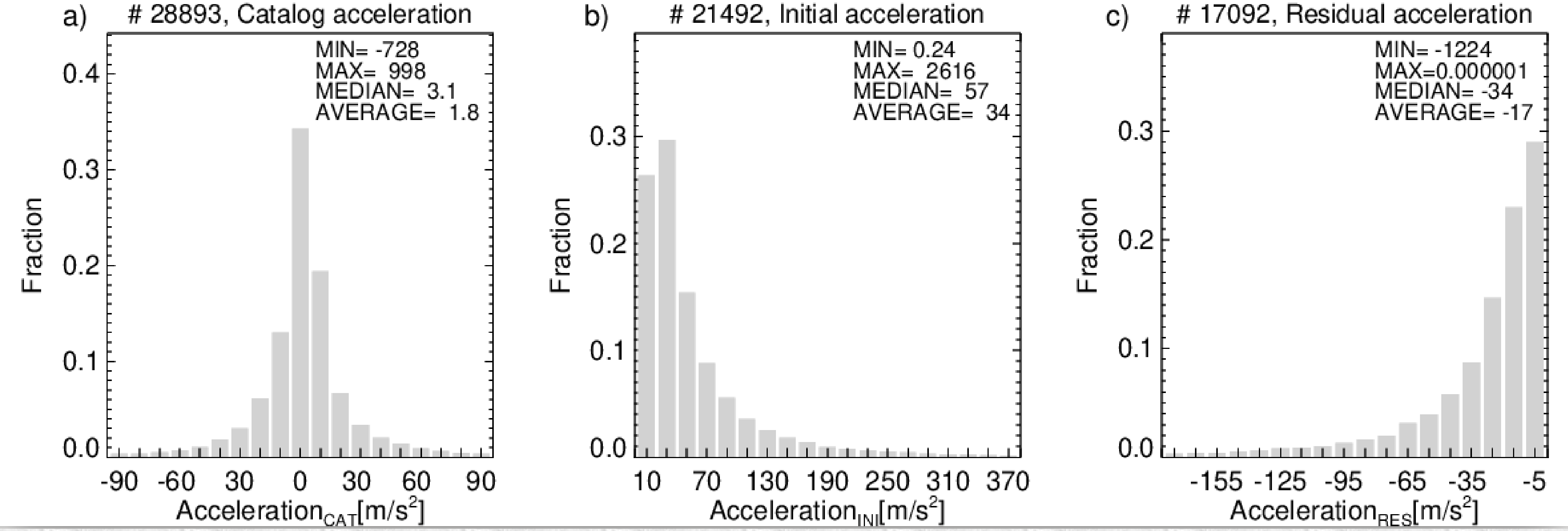
- Initial Acceleration = V_{max} / (T_{max}-T_{onset})
- Residual Acceleration = (V_{res}-V_{max}) / (T_{res}-T_{max})

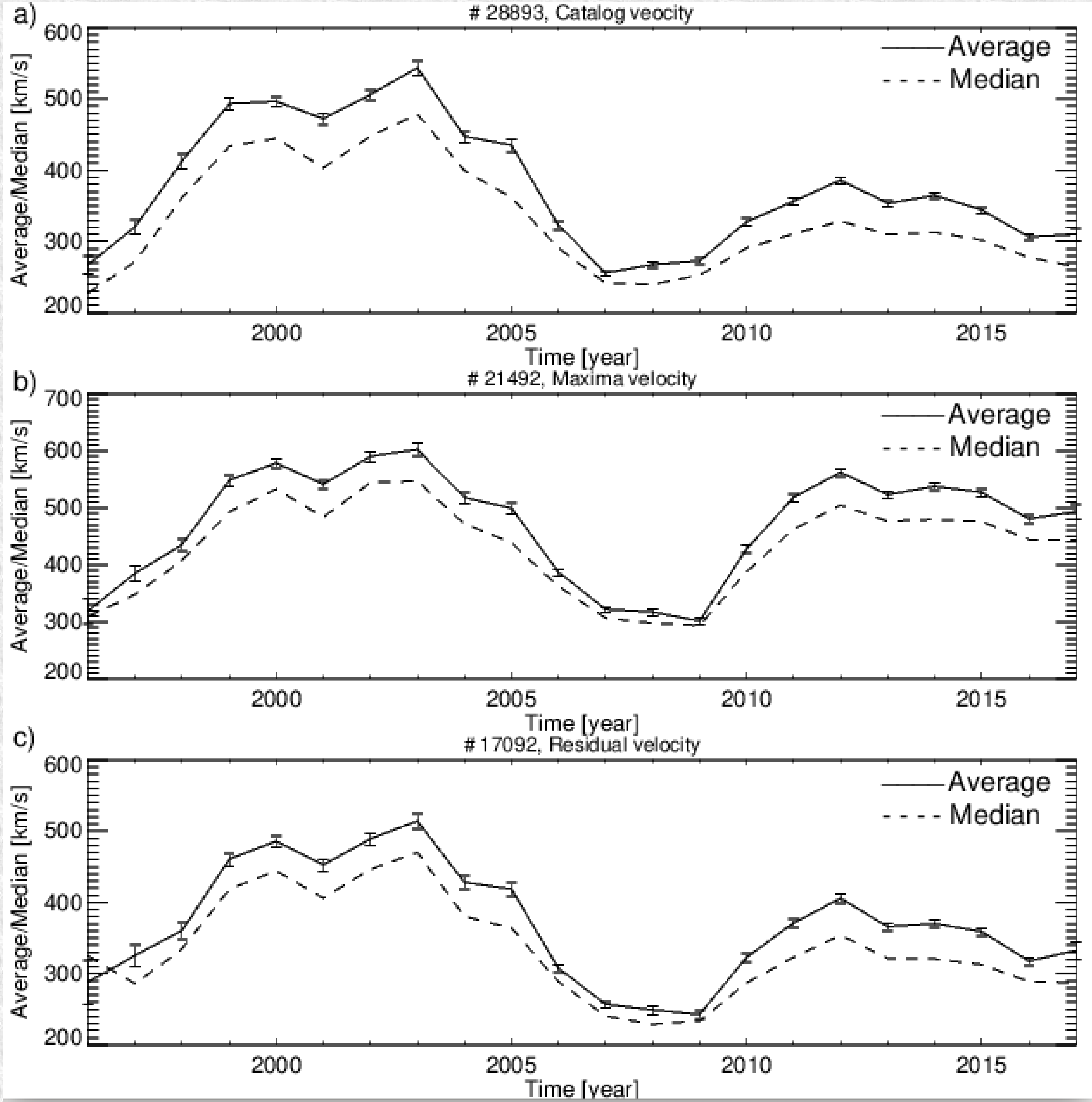


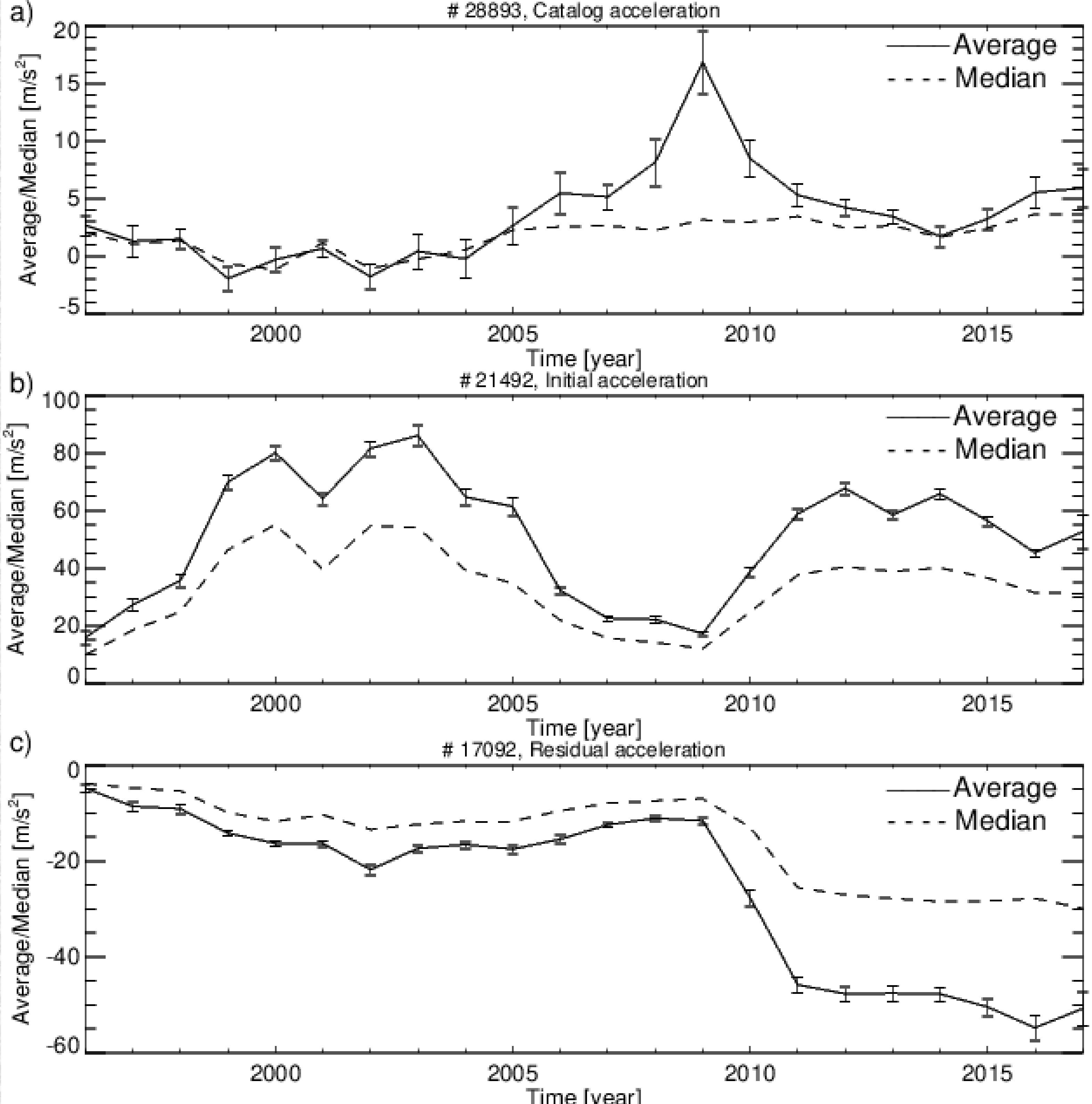
Distribution of velocity

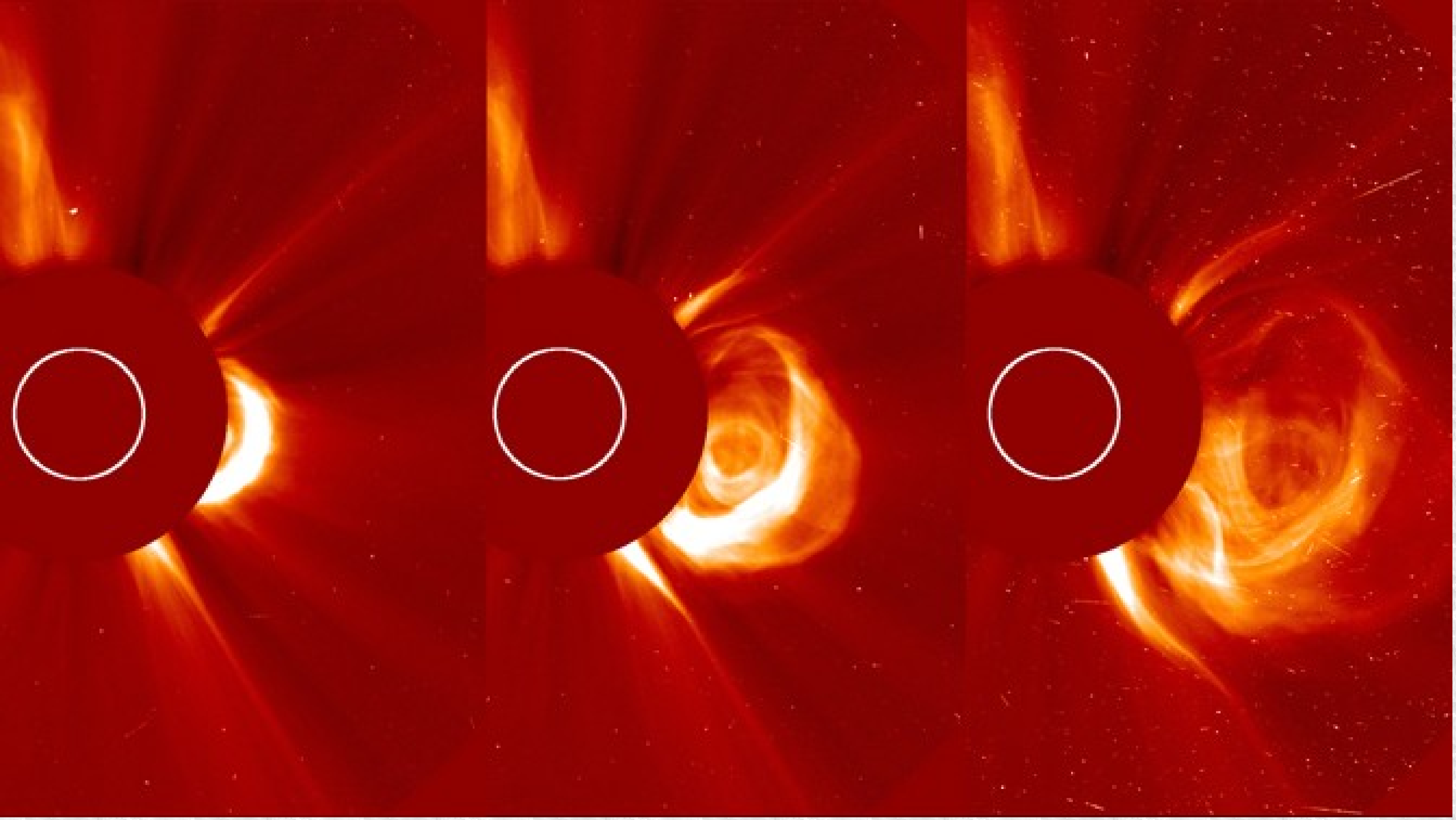


Distribution of Acceleration




a)
28893, Catalog veocity
Average
Median
Average/Median [km/s]
600
500
400
300
200
2000
2005
2010
2015
Time [year]
b)
21492, Maxima velocity
Average
Median
Average/Median [km/s]
700
600
500
400
300
200
2000
2005
2010
2015
Time [year]
c)
17092, Residual velocity
Average
Median
Average/Median [km/s]
600
500
400
300
200
2000
2005
2010
2015
Time [year]


a)
28893, Catalog acceleration
Average
Median
Average/Median [m/s2]
Time [year]
b)
21492, Initial acceleration
Average
Median
Average/Median [m/s2]
Time [year]
c)
17092, Residual acceleration
Average
Median
Average/Median [m/s2]
Time [year]



Gopalswamy et al., 2015;

- The reduced cloud spedd at 1 AU can be attributed to the enhanced drag in SC 24 due to diminished solar wind speed and increased CME size.

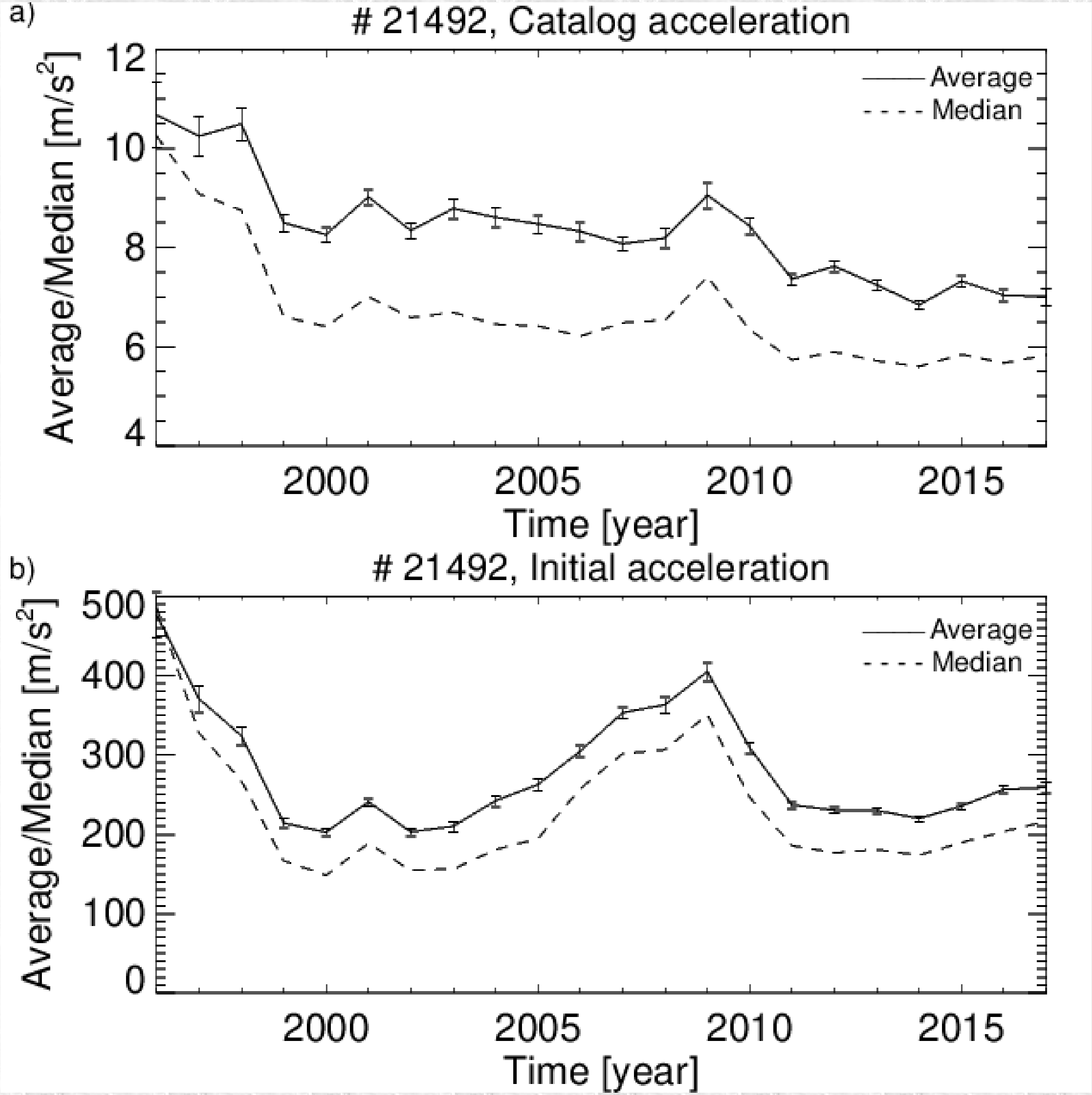
- Since the drag force is proportional to the square of the speed difference between the CME and the solar wind, a slower wind will result in a larger drag.

- Similarly the drag is also proportional to CME cross sectional area, so wider CME in cycle 24 provides a larger area and increases the drag.

Summary

- A statistical analysis of the Coronal Mass Ejections recorded by SOHO/LASCO during Solar Cycles 23 and 24, 1996 – 2017.
- The initial acceleration is in the range 0.24 to 2616 m/s2 with a median (average) value of 57 (34) m/s2.
- The residual acceleration is in the range -1224 to 0 m/s2 with a median (average) value of -34 (-17) m/s2.
- The residual acceleration is much smaller during solar cycle 24 than the 23rd cycle.
- The space weather during Solar Cycle 24 was extremely mild. A significant drop in the density, magnetic field, total pressure and solar wind.

Future work



Panel a: Solar cycle vs Rmax
Panel b: Solar cycle vs Tmax