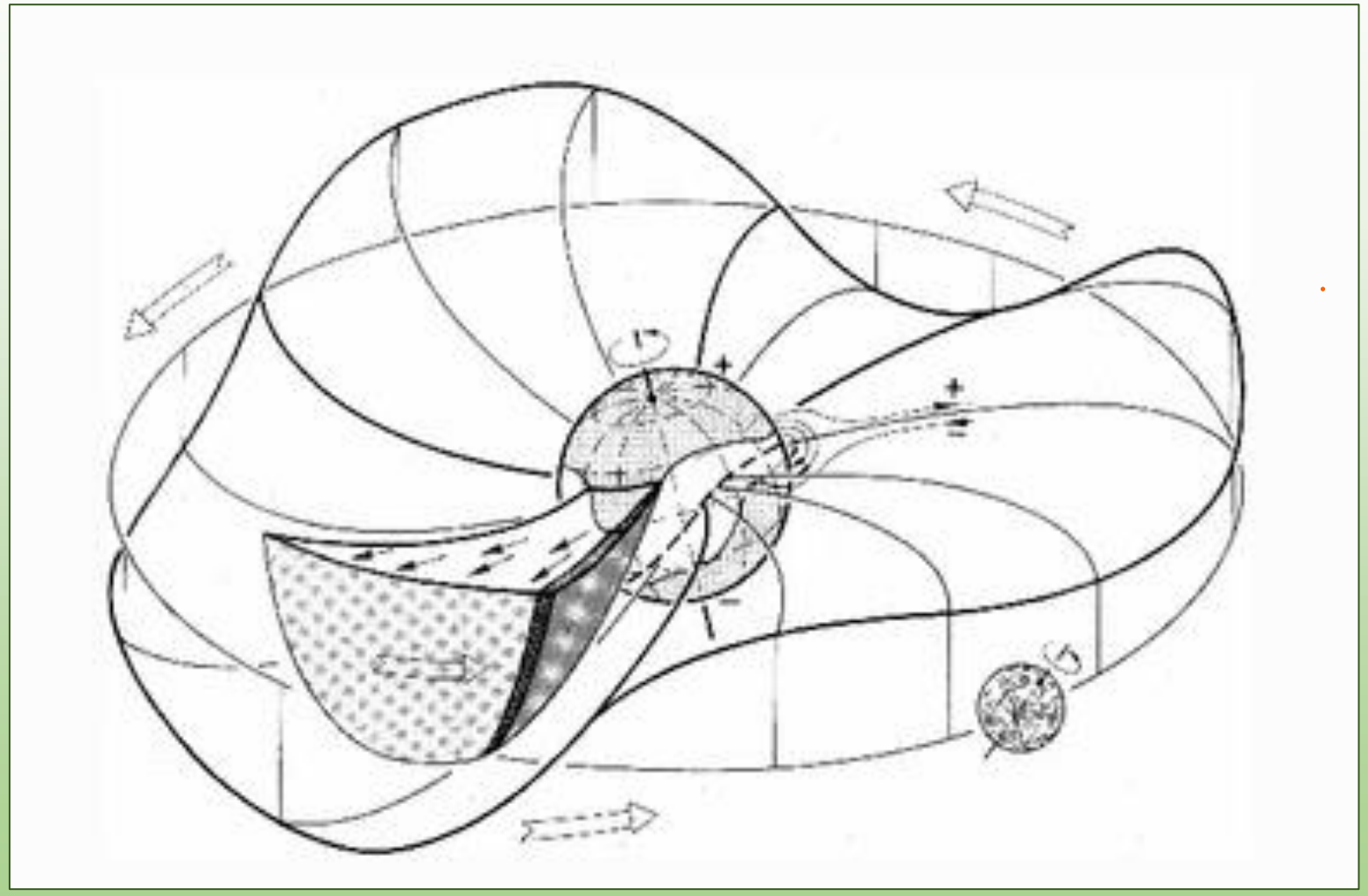
Merged interaction regions propagation in the inner heliosphere and their effect on coronal mass ejections

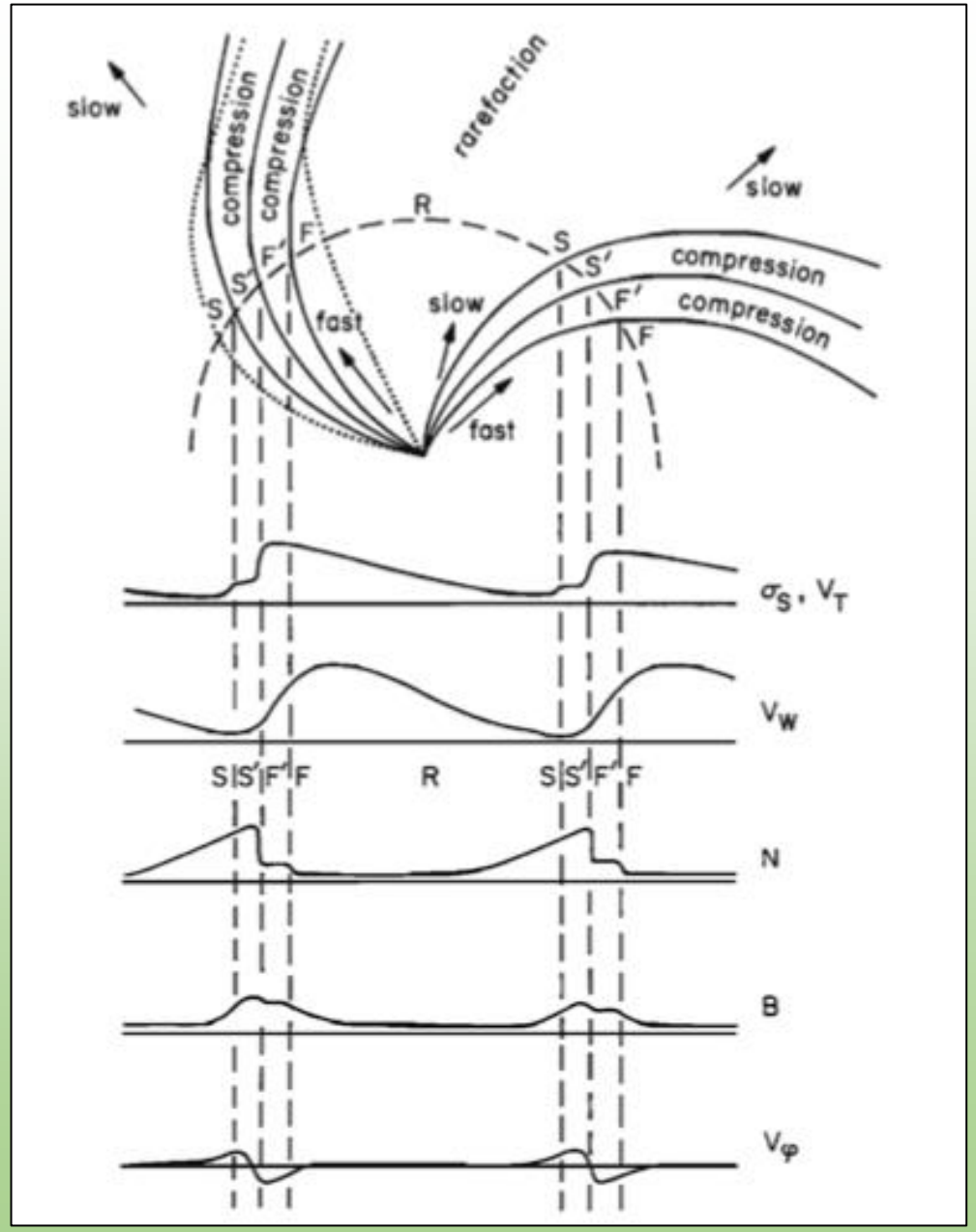
Presentation by Carlos R. Braga

SIRs/CIRs/MIRs

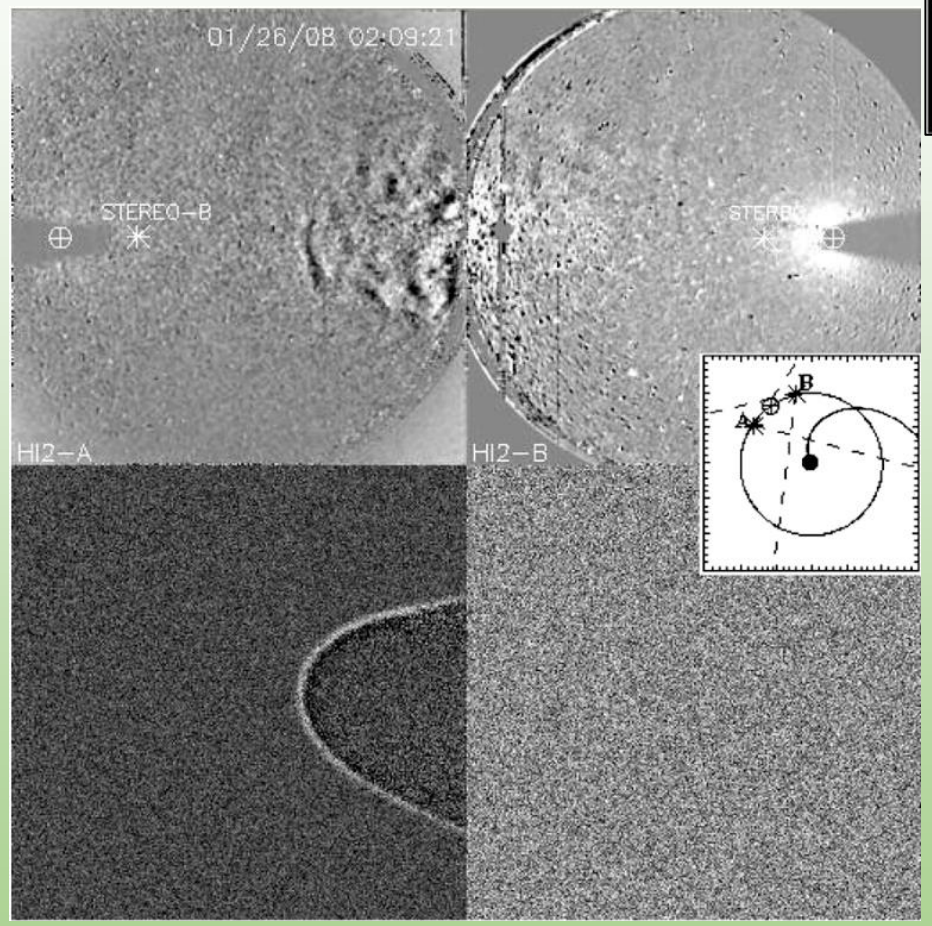
- stream interaction regions (SIRs)
- corotating interaction regions (CIRs)
- Merged interaction regions (MIRs)



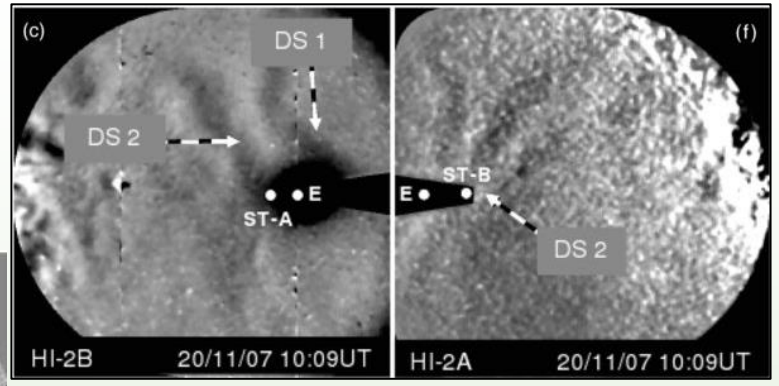
Schwenn (1990)

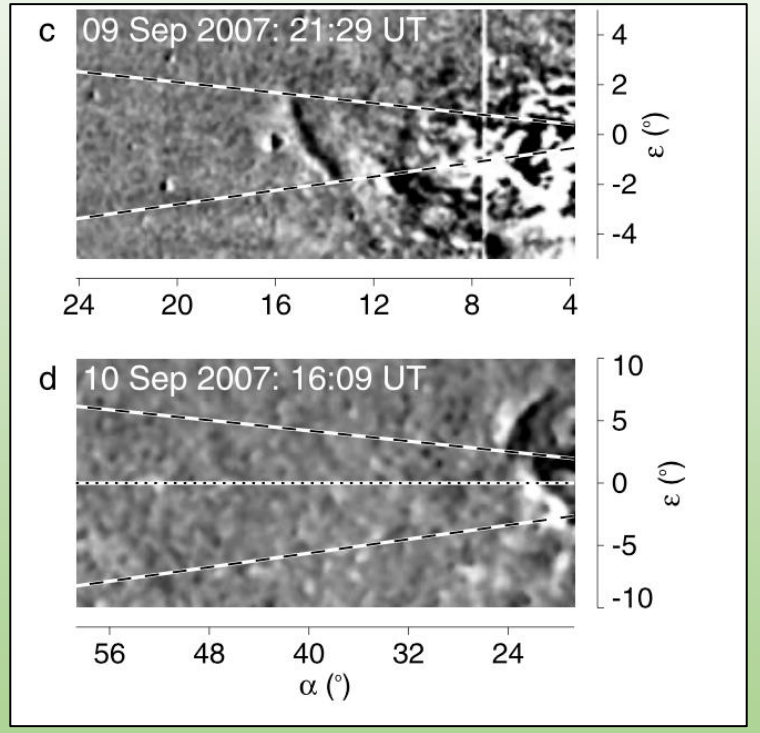


Belcher & Davis (1971)

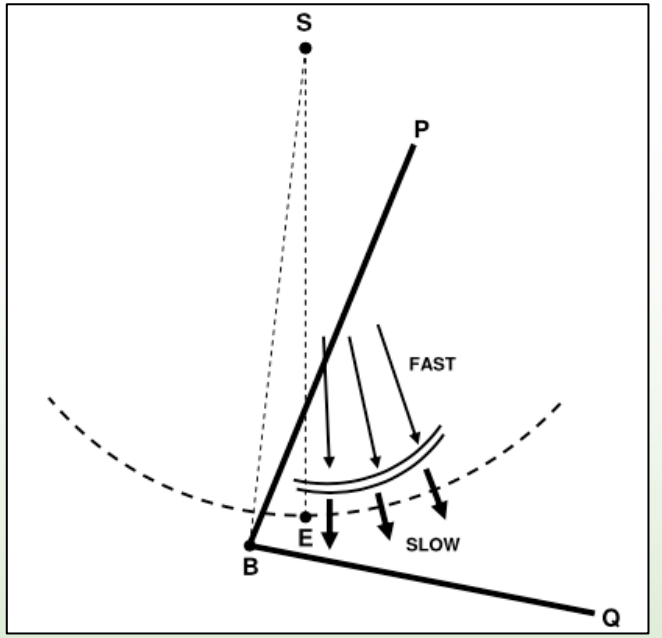


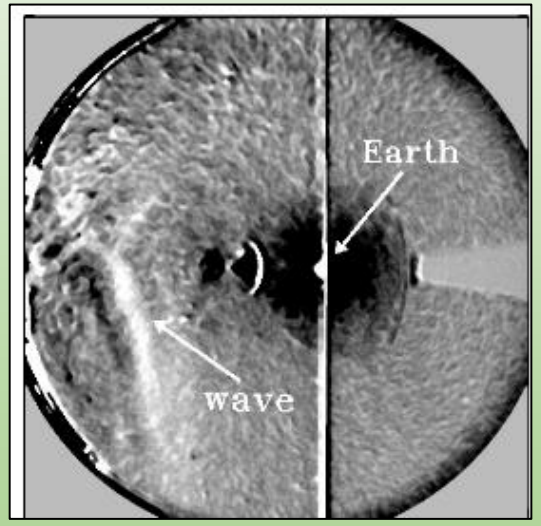
Wood et al. (2010) ApJL





Rouillard et al. (2008) GRL





Sheeley et al. (2008) ApJ

Objective

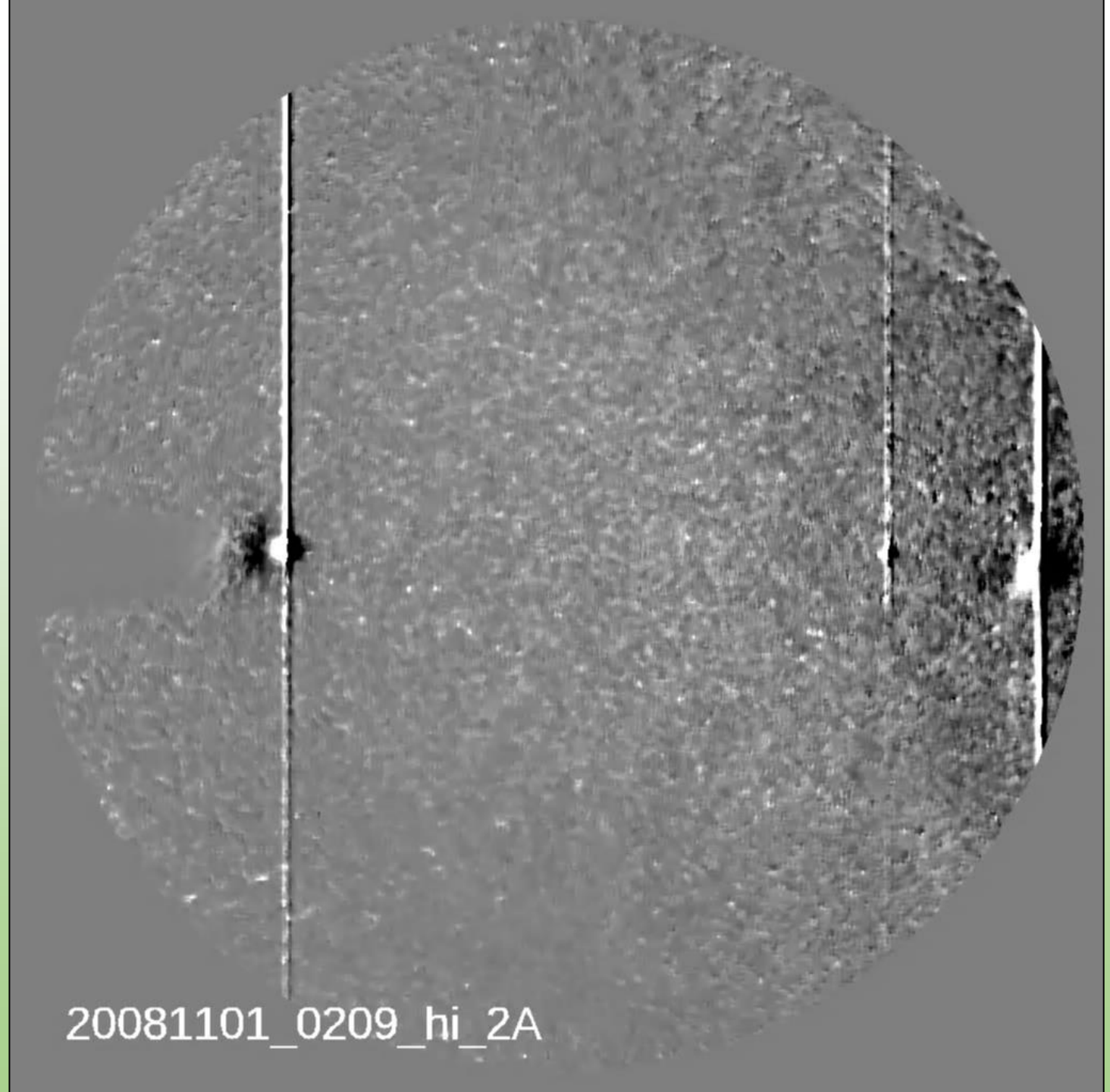
to improve the physical understanding of the interplanetary evolution

of

- stream interaction regions (SIRs),
- corotating interaction regions (CIRs)
- coronal mass ejections (CMEs) interacting with SIRs/CIRs to form the merged interaction regions (MIRs).

in

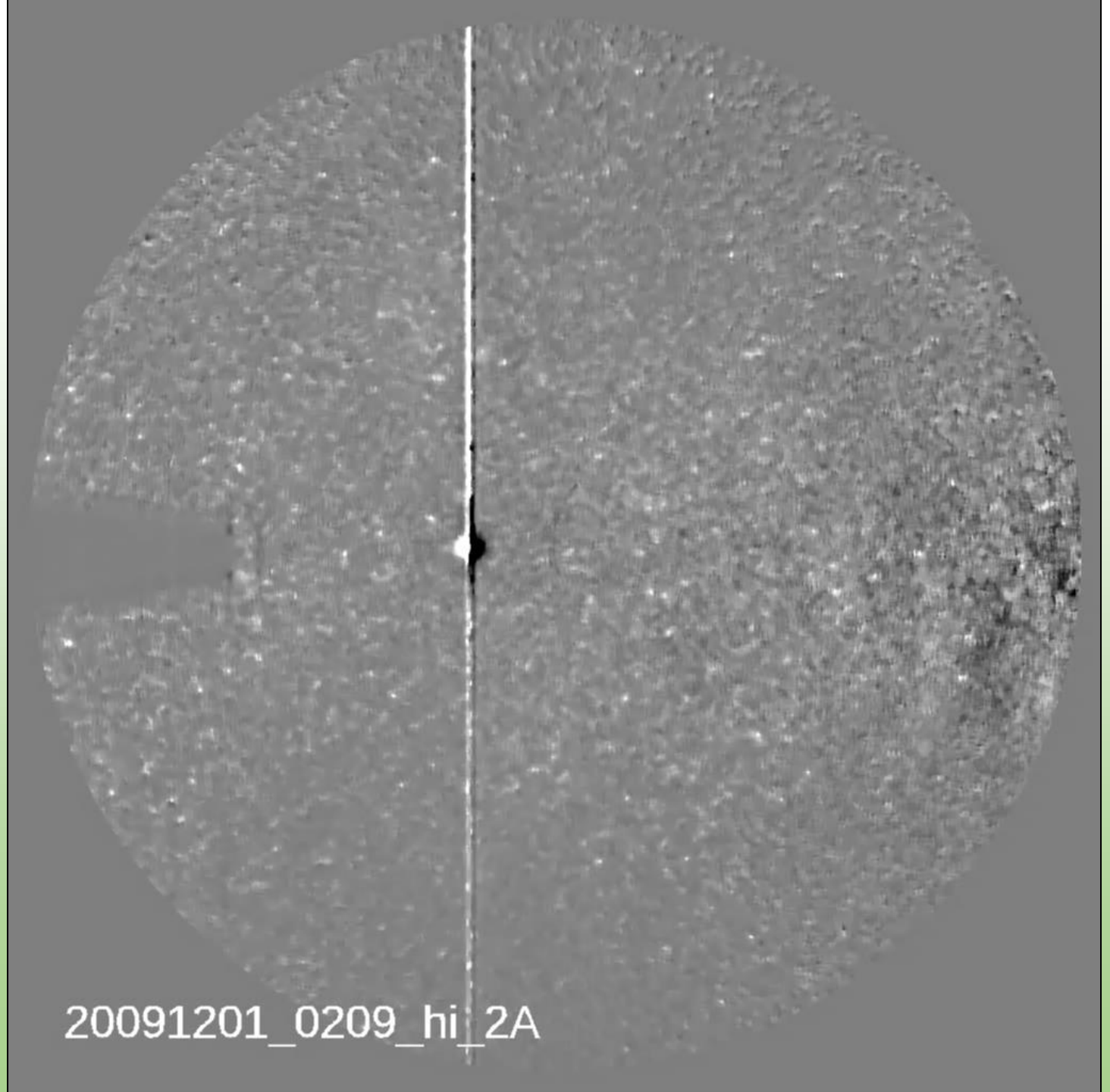
- space (up to 1 au)
- time (solar cycle)

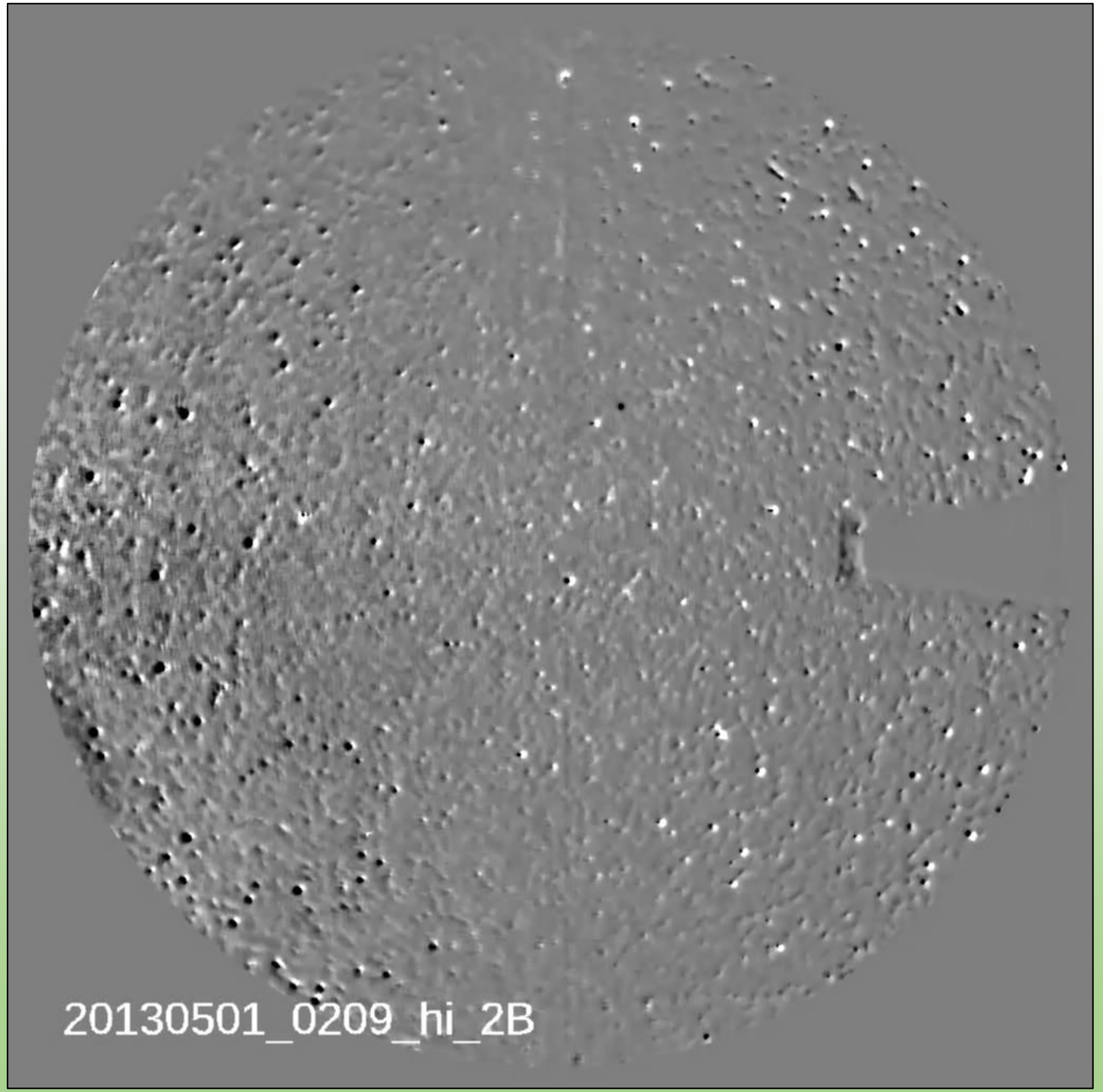


Nov 5-7

Nov 20-26

Nov 26-29


20091201_0209_hi_2A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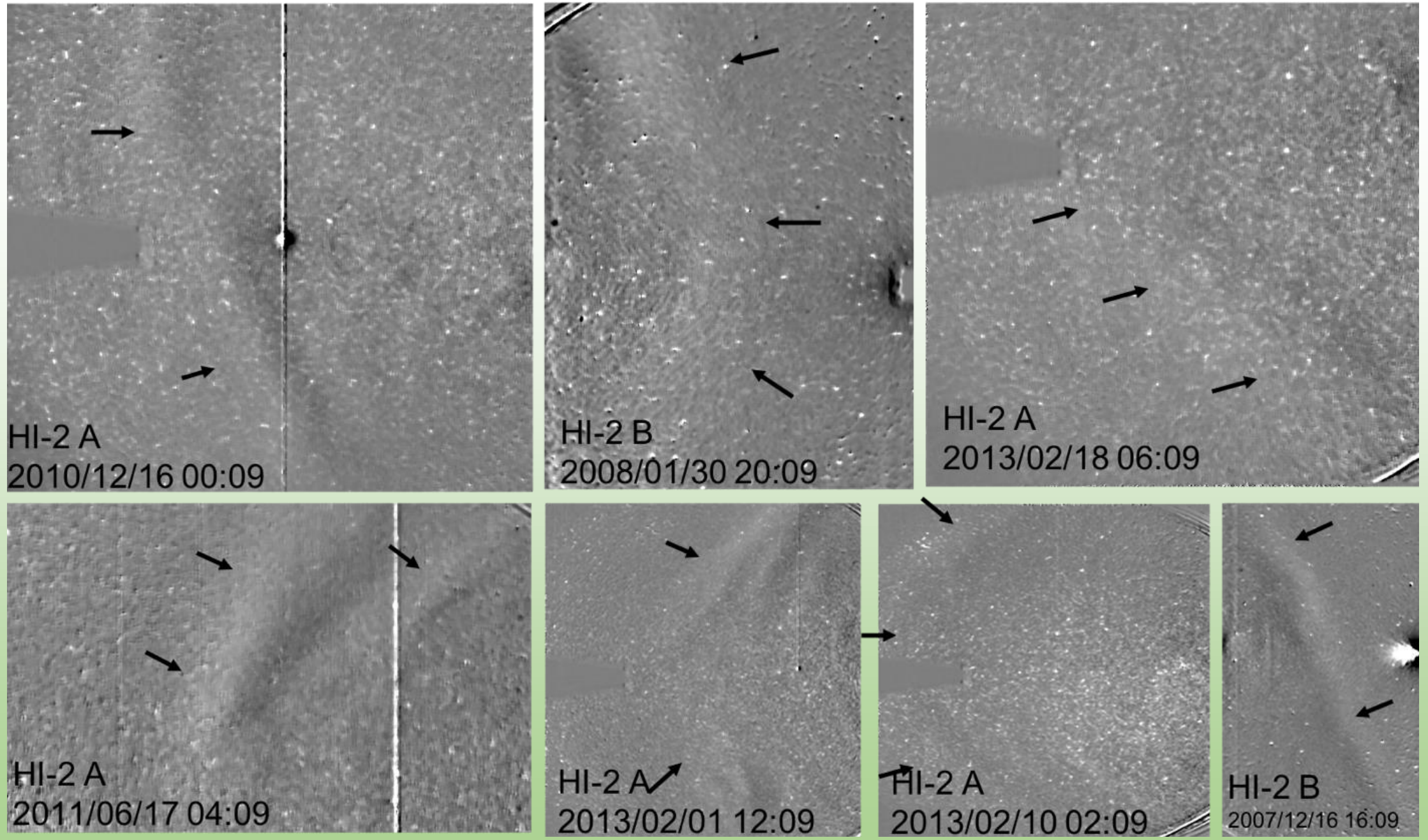

HI-2 A
2010/12/16 00:09
HI-2 B
2008/01/30 20:09
HI-2 A
2013/02/18 06:09
HI-2 A
2011/06/17 04:09
HI-2 A
2013/02/01 12:09
HI-2 A
2013/02/10 02:09
HI-2 B
2007/12/16 16:09

Synthetic images

Electron density in space model

Thomson scattering

Heliospheric image camera properties:
S/C attitude, position, position of each pixel, camera deformation

Synthetic image

Forward modelling

Synthetic image HI-2 A

Synthetic image HI-2 B

HI-2 A Observations

HI-2 B Observations

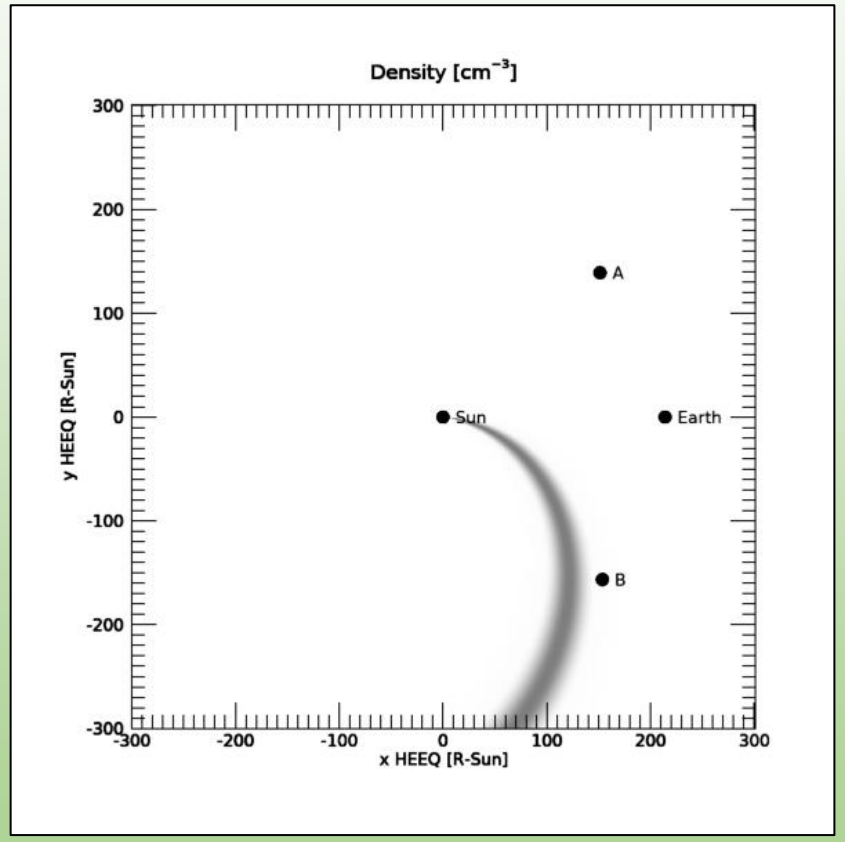
In situ measurements A (timing)

In situ measurements B (timing)

In situ other source (MAVEN, WIND, PSP, SO)

3d Electron density in space model

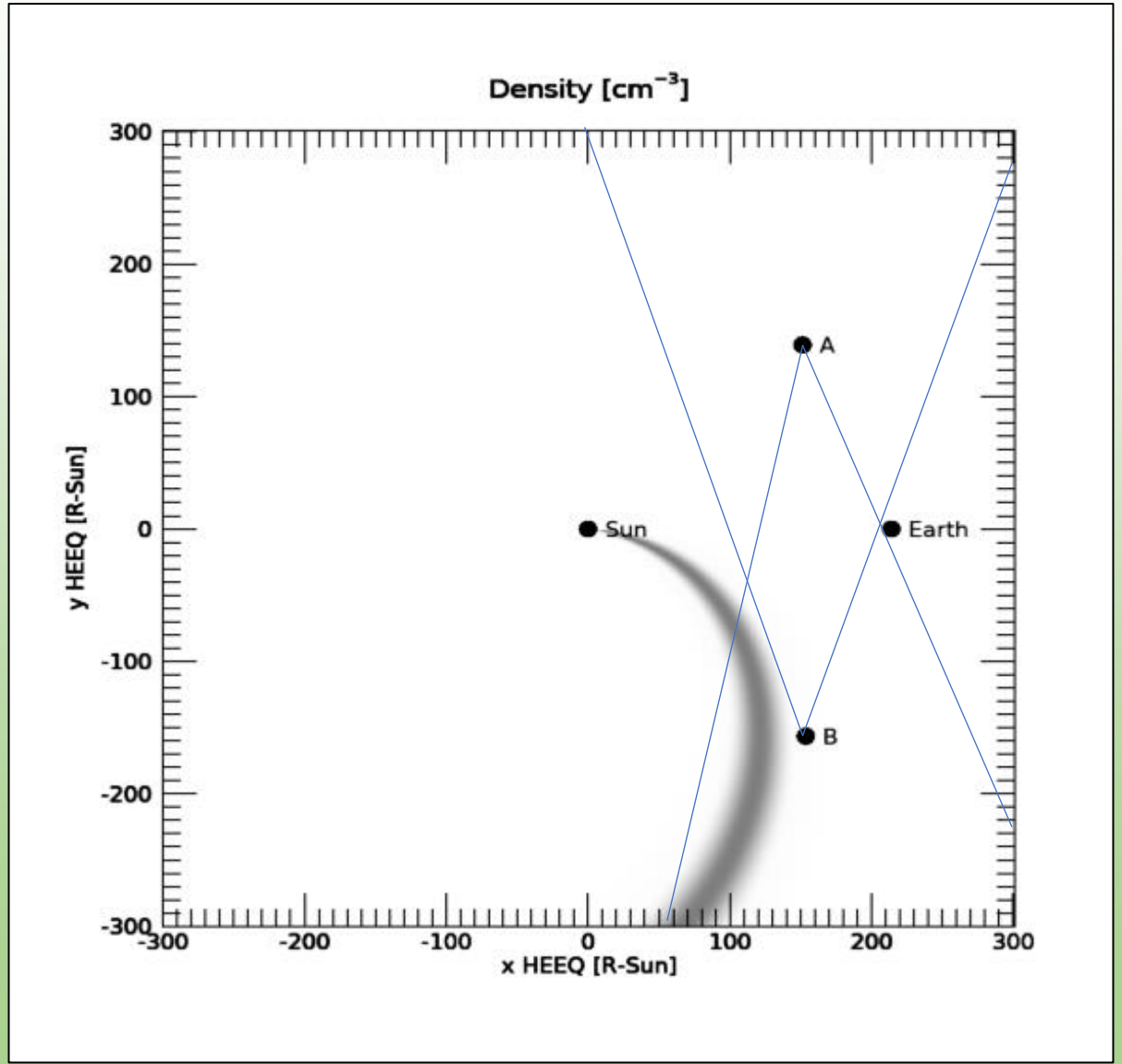
Candidate events



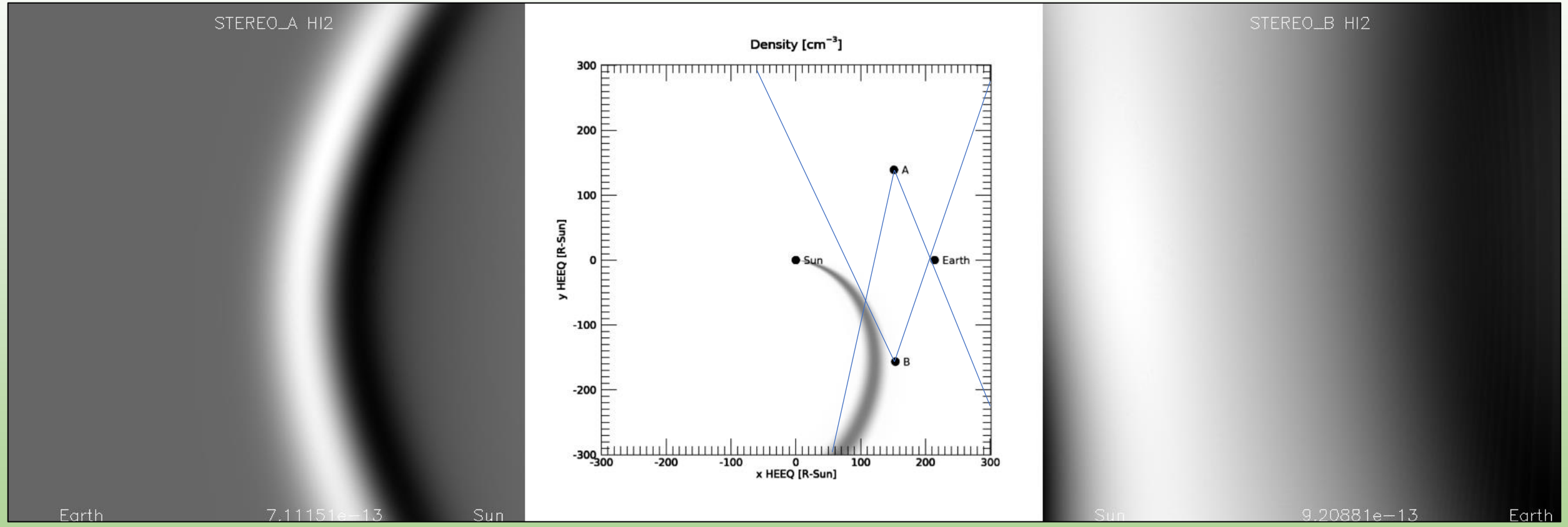
- HI-2 A
- HI-2 B
- B in situ (Jian et al. catalog)
- A in situ (Jian et al. catalog)

- 20+ events just in 2008
- 100+ between 2007 and 2014

Electron density in the equatorial plane



Synthetic image



Impact

- SIR/CIRs are the main drivers of terrestrial space weather during solar minimum;
  - implications for thermospheric drag (e.g McGranahagan et al 2014).
- SIRs are associated to the production of energetic particles (Richardson, 2018).
- SIRs associated to CMEs are generally more geoeffective than “pure” SIRs (Tsurutani et al., 1982).
  - SIRs-> weak and moderate geomagnetic storms
  - SIRs with CMEs -> intense geomagnetic storms (Zhang et al., 2008).

Summary

- SIR/CIRs/MIRs can be associated to shocks, termospheric drag, moderate (intense geomagnetic storms);
- We have a solar cycle of observations from STEREO (100+ events);
- SIR/CIRs are better observed thanks to new methodologies to remove F-corona, star field from the images;
- We are developing a new forward model for SIR/CIRs.

Thank you!